Mechanically Operated Cutting and Welding Torches

By Edward K. Hammond[1]

For the performance of manufacturing operations where cutting or welding torches are used, and for handling certain miscellaneous classes of work where the oxy-acetylene torch finds application, higher rates of production and greater uniformity in the work are secured through operating the torch by some suitable mechanism than is the case when it is moved over the work by hand. The substitution of a uniform mechanically controlled movement in place of operating a torch by hand enables the torch to be moved over the work at a rate which has been carefully predetermined after consideration has been given to the thickness of the metal and other variable conditions which are involved in any welding or cutting operation. This article explains a variety of different methods of using mechanically controlled cutting and welding torches, and these applications will doubtless suggest other ways in which readers of MACHINERY can apply mechanical control for torches used in their own shops.

MANUFACTURERS who have use for oxy-acetylene cutting or welding torches will find that several important advantages are secured through operating the torches mechanically, when such a method of procedure is practicable. Most important among the benefits secured from mechanical control are increased production from the torches and greater uniformity in the work. Experience is required to enable the operator of a cutting or welding torch, working by hand, to produce uniform cuts or strong welds of good appearance, although such results are readily obtained by an intelligent mechanic who is given the necessary amount of time to acquire dexterity in handling a torch. But this skill can only be obtained by experience, and in plants where there is not a great amount of cutting or welding to be done, it often happens that inexperienced men are expected to use a torch and produce work which is comparable with that turned out by experts. Quite naturally, this is not often possible in practice. In such shops, the use of mechanically operated torches eliminates the personal equation and greatly improves the quality of the work; mechanical control is also the means of increasing production, as the torches are moved by power at the correct rate, which is predetermined by the design of the feed mechanism. Thus, the elimination of the personal equation increases both the quantity and quality of the work produced; even in shops where experienced cutters and welders are employed, these men are likely to become tired during the latter part of the day, with the inevitable result that they will produce less work and work of inferior quality.

For performing the miscellaneous cutting and welding operations that are met with in many different shops, manufacturers of oxy-acetylene torches have made mechanically operated equipments which are well adapted for general requirements. On the other hand, there are many specialized manufacturing operations for which mechanically operated cutting and welding torches can be used to extremely good advantage, where the peculiar requirements of the work make it necessary to design special machines to fulfill existing conditions. In such cases, it will generally be found possible to employ standard oxy-acetylene torches in connection with these special machines; in fact, this is almost invariably the method of procedure which is followed, because the standard torches are designed along lines which have been found satisfactory in practice. Owing to the highly explosive character of acetylene, hydrogen, and other combustible gases which are used in torches, it is, of course, absolutely imperative either to use standard torches or else to be sure that special torches are so

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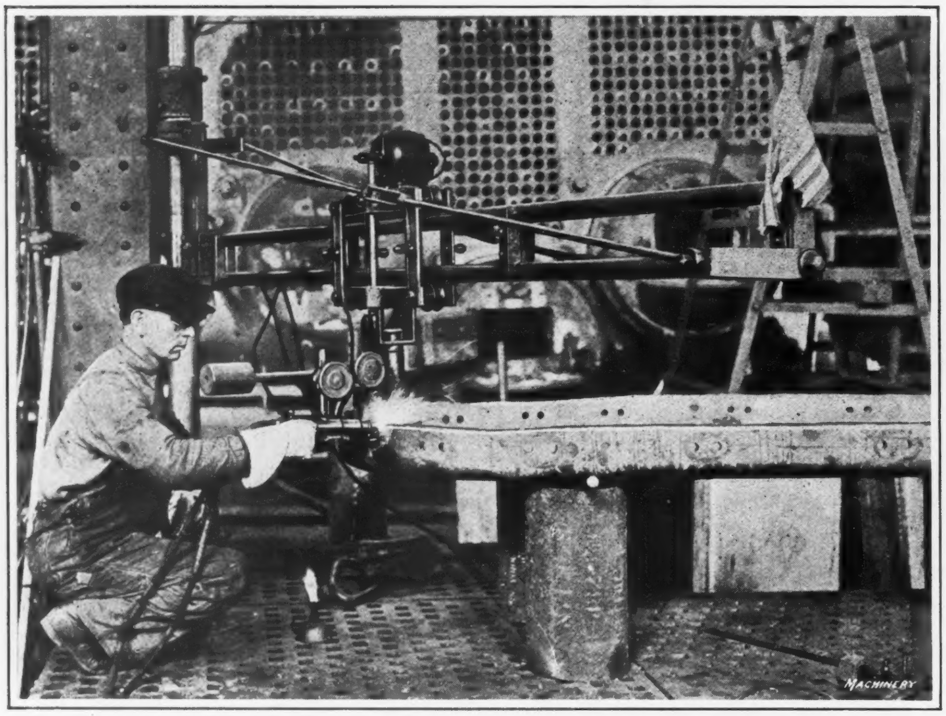

Fig. 1. Practice of New York Shipbuilding Corporation in cutting off Ragged Edge of a Boiler Head or Similar Shaped Piece which has a Flange turned up around its Circumference

designed that the proper precautions have been taken to avoid danger of explosions caused by flash-backs, etc.

Mechanically Controlled Cutting Torches

Provision can be made for the mechanical control of cutting torches that are adapted for working on parts of a variety of different shapes and sizes, which will be clearly demonstrated by reference to Figs. 1 to 13. An inspection of these illustrations will show that, in addition to making straight cuts on flat plates, it is quite feasible to follow irregular outlines on flat plates or to make cuts on cylindrical shaped pieces. With many of these mechanically controlled equipments, the torches are guided in such a way that they follow the line along which it is desired to make a cut, without calling for special attention from the operator, and, as previously mentioned, provision of power drive sets the pace for the torch, so that it is fed to the work at a predetermined speed which is suitable for the thickness of the metal that is being cut.

Figs. 1 and 2 show two methods used at the plant of the New York Shipbuilding Corporation in Camden, N. J., for cutting off the ragged edges of such pieces as boiler heads, which have a flange drawn up around the circumference. In Fig. 1 the torch is shown trimming off the flange of a boiler front, which is made of a steel plate 1¼ inch in thickness. It will be apparent from this illustration that the torch is supported by a head carried on the radial arm of a machine which is so designed that the torch head can be traversed in either direction on the radial arm, and this arm can be swung around the column of the machine. This combination of movements enables the torch to be fed around the edge of cylindrical shaped pieces, as shown. The torch head is furnished with wheels which engage both the inside and outside of the work to provide for holding the point of the torch in the proper relation to the plate which it is cutting. An electric motor, which will be seen above the radial arm, transmits power to these wheels on the head, so that they serve the double purpose of holding the torch in the proper relation to the work and feeding it over the work at the proper rate. In cutting this 1¼-inch steel plate with carbo-hydrogen gas, using a Davis-Bournonville torch with a No. 3 cutting tip, it is found possible to cut at a rate of 1 foot per minute and leave a sufficiently good finish, so that no subsequent machining operation is required.

Fig. 2 shows another method used by the New York Shipbuilding Corporation for cutting away the ragged edge of a cylindrical shaped flange, where the size of the work is too great to enable it to be handled by the radial cutting machine shown in Fig. 1. The steel is of the same thickness as in the preceding case and the rate of cutting is also the same. In this illustration it will be seen that the cutting torch is swung around a center *A*; and extending from this center to the torch there is a radial arm *B* which holds the torch point in the proper relation to the work. In this case, use is made of one of the "radiagraph" machines built by the Davis-Bournonville Co., of Jersey City, N. J., which is used in conjunction with the radial arm and center for performing cylindrical cutting operations of this kind with very satisfactory results. Radiagraph machines are also shown in operation in Figs. 3 to 6, and the description of the mechanism will be best understood by referring to these illustrations.

This machine consists of a carriage that holds the cutting torch with its tip at a suitable distance from the work and feeds the torch over the work in making the cut. Where the radiagraph is used for making straight cuts on flat plates, it is usually the practice to provide a small double track for the wheels of the torch carriage. On top of the carriage, in Fig. 3, there will be seen a small electric motor *A* that transmits power to the wheels through a suitable arrangement of gearing, thus providing for feeding the torch to the work at a speed suitable for the thickness of metal that is being cut.

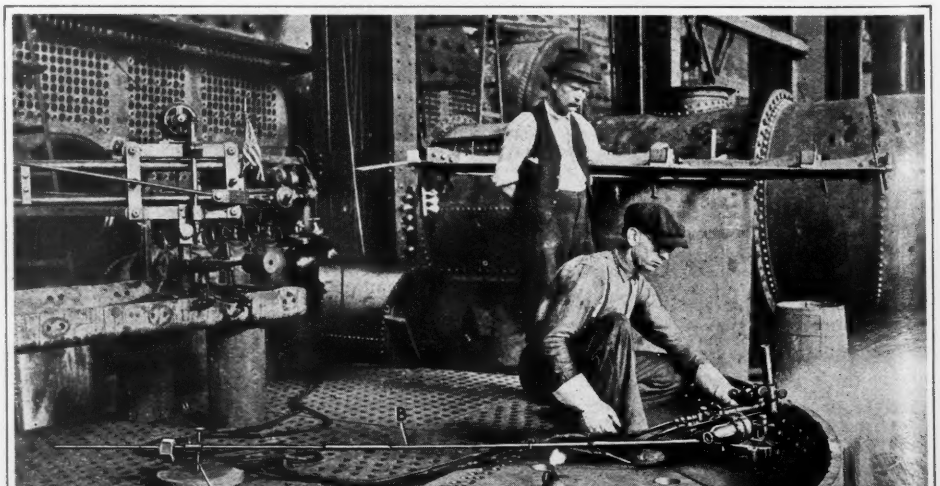

Fig. 2. Use of a Davis-Bournonville "Radiagraph" in the Plant of the New York Shipbuilding Corporation for cutting off Ragged Edge of Flange

Fig. 3. **Using "Radiagraph" to make a Longitudinal Cut on Flange of I-beam in Plant of Marion Steam Shovel Co.**

Fig. 4. **Same Work illustrated in Fig. 3, showing All the Cutting Operations which are performed**

The track that carries the wheels of the radiagraph is shown at *B*, and at *C* it will be seen that a rack and pinion are provided to regulate the position of the torch tip so that it is located at a suitable distance from the surface of the work.

Figs. 3 and 4 show two views of a radiagraph machine engaged on the operation of cutting I-beams in the plant of the Marion Steam Shovel Co., in Marion, Ohio. The work consists of Bethlehem 30-inch I-beams with 10½-inch flanges. Eight of these beams are put through the plant at a time, this being the number required in a unit for one large Marion shovel. Each end of the flange at the top and bottom of the beam is coped off, two ends being cut diagonally and two straight across; a longitudinal cut is also made along one flange, as shown in Figs. 3 and 4. Formerly the coping operation was performed with a swivel saw, but this naturally necessitated a great deal of handling of the work, which has now been eliminated. For making the longitudinal cut, it was formerly the practice to set the work up on a planer, two beams being set up and operated upon simultaneously. It required about from thirty to forty-five minutes to set up these two beams, and then about an hour to make the required cut in each beam. This involved a total time of one and three-fourths hour for cutting two beams, or seven hours for cutting eight beams. Doing this work with a mechanically operated oxy-acetylene cutting torch, one longitudinal cut is made in six minutes, the length of cut being 4 feet 3 inches by 1½ inch in thickness. Instead of taking from fifteen to twenty hours for sawing the ends of the beams and seven hours for planing, the whole operation of coping and longitudinal cutting is done with the mechanically operated cutting torch in five hours, which includes all the time spent in setting up, etc.

Fig. 5 shows how the New York Shipbuilding Corporation employs the radiagraph machine for cutting flat plates. This is one of the simplest applications, the machine being carried on a track which guides it over the surface of the steel plate being cut. This illustration shows the cutting of a plate 2½ inches thick, and the torch is fed at the rate of 13 inches per minute, leaving a good finish on the cut surface. In Fig. 2 is shown the way in which the radiagraph is employed for trimming the rough edges from a boiler head. Fig. 6 shows another application of the radiagraph for circular cutting in the New York Shipbuilding Corporation's plant, which is based on essentially the same principle, although in this case the diameter of the circular cut is very much less. The operation consists of cutting a number of circular openings in a plate 1½ inch in thickness, and for handling this operation the radiagraph is furnished with a radial arm *A*, which is attached to a fixed center *B*. The torch is fed over the work at the rate of one foot per minute. An interesting feature of this particular application of the mechanically operated cutting torch is the manner in which a track is provided for the carriage wheels. It will be seen that there is a break in the surface of the work left by a previous cut, which would interfere with the carriage travel; to overcome this difficulty, a thin plate is placed on top of the work to be cut, this plate having an opening sufficiently large to allow the point of the torch to make the desired cut and still furnish a bearing for the carriage wheels.

Fig. 5. **Using Davis-Bournonville "Radiagraph" at Plant of New York Shipbuilding Corporation for making Longitudinal Cut on Large Steel Plate**

Fig. 6. **Application of "Radiagraph" by New York Shipbuilding Corporation for cutting Circular Disks from Steel Plate. Note Method of carrying Wheels over Holes**

Cutting Torch Used as Lathe Tool

In making rotors for steam turbines, it is the practice of the New York Shipbuilding Corporation to pour the molten steel into a mold which is made so that the rotor casting stands on end. The reason for this arrangement is that, by making the mold higher than is necessary to produce a casting of the required length, the excess amount of molten steel forms a riser that applies pressure and assists in producing a solid casting. Obviously, it is necessary to cut off the surplus metal during the process of machining this steel casting to convert it into a finished turbine rotor, and for this purpose it is the practice to set the casting up on a large engine lathe as shown in Fig. 7. Supported in this way, it is an easy matter to rotate the casting at a suitable speed, so that a cutting torch, supported in the proper relation to the work, will have the steel fed to the torch at the proper rate for making the cut. This rotor casting is 9½ inches thick by 16 feet 6 inches in circumference, and the cut was completed by the oxy-hydric torch in the remarkably short time of thirty-five and one-half minutes. A good idea of the quality of the finished surface left by the torch will be gathered from the illustration.

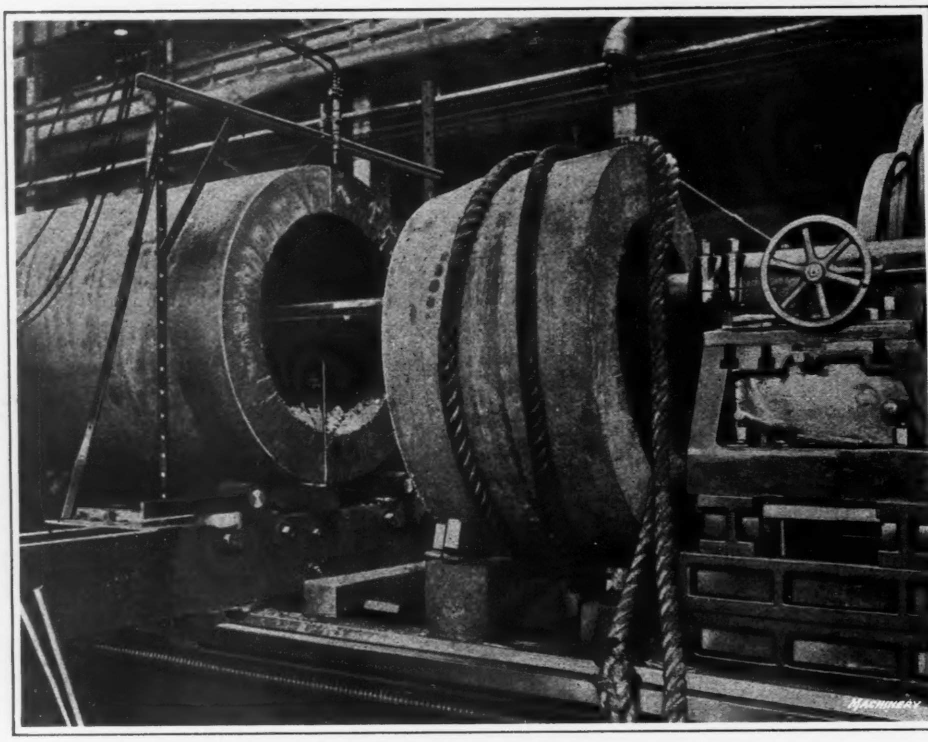

Fig. 7. New York Shipbuilding Corporation makes Body of Steam Turbine Rotors of Cast Steel, and the Ends of These Castings are cut off by rotating Work on Lathe to feed it to Flame of Davis-Bournonville Cutting Torch

Combustible Gases Used for Cutting in New York Shipbuilding Plant

In the plant of the New York Shipbuilding Corporation, three different combustible gases are used in cutting torches, namely, carbo-hydrogen, acetylene, and hydrogen. The combustible gas selected for different classes of work depends upon the thickness of the plates which have to be cut. The range of thicknesses handled by the different gases is as follows: up to 3 inches, carbo-hydrogen; 3 inches to 6 inches, acetylene; and over 6 inches, hydrogen. It will, of course, be understood that either of these gases is mixed with oxygen to provide for its combustion, the ratio of oxygen to the combustible gas being regulated in accordance with standard practice, which has been explained in other articles published in MACHINERY.

Users of cutting and welding torches are certainly familiar with the properties of both hydrogen and acetylene, but it may be that there are some readers who have not had occasion to investigate the properties of carbo-hydrogen. This gas contains from 85 to 88 per cent hydrogen and 15 to 12 per cent light hydro-carbons of the higher heating series. It is claimed that less oxygen is required for the combustion of this mixed gas than for either acetylene or hydrogen; and that the temperature of the carbo-hydrogen flame is approximately 4800 degrees F. In referring to the properties of combustible gases which make them suitable for use in cutting and welding torches, confusion frequently arises through a misconception of the relation which exists between the number of heat units per cubic foot of a gas and the temperature which can be developed by the combustion of that gas. For the performance of cutting or welding operations, the number of heat units per cubic foot of gas is a matter of minor importance in determining its ability to give efficient service; it is the rapidity with which this heat is liberated to develop a high temperature which determines the suitability of the gas for use in a torch. This fact is well brought out by comparing the heat value of carbo-hydrogen with that of ordinary illuminating gas, the former having approximately 480 British thermal units of heat per cubic foot, while the latter has approximately 600 heat units per cubic foot. Despite this fact, illuminating gas is unsuitable for use in a torch because, although it has 25 per cent more available heat per unit volume of gas, this heat is not liberated rapidly enough to generate a temperature suitable for the cutting or welding of metals.

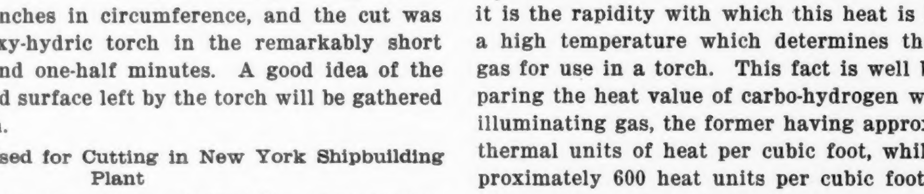

Fig. 8. Davis-Bournonville "Oxygraph" equipped with Single Torch which follows Same Outline as that over which Tracing Point is guided on Copy Table

It is claimed by the Carbo-Hydrogen Co. that this gas has readily cut armor plate up to 24 inches in thickness, using standard apparatus, and that open-hearth steel pit castings 36 inches thick at the center by 17 inches thick at the edges, and 10 inches across, have been cut in half by special apparatus, using carbo-hydrogen as the combustible gas. For this work a number of oxygen cylinders were manifolded together and a preheating flame was used, which was provided by a torch fitted with a ¼-inch gas pipe taking oxygen directly from the manifold oxygen supply. Of course, this was an unusual operation, and the cut was

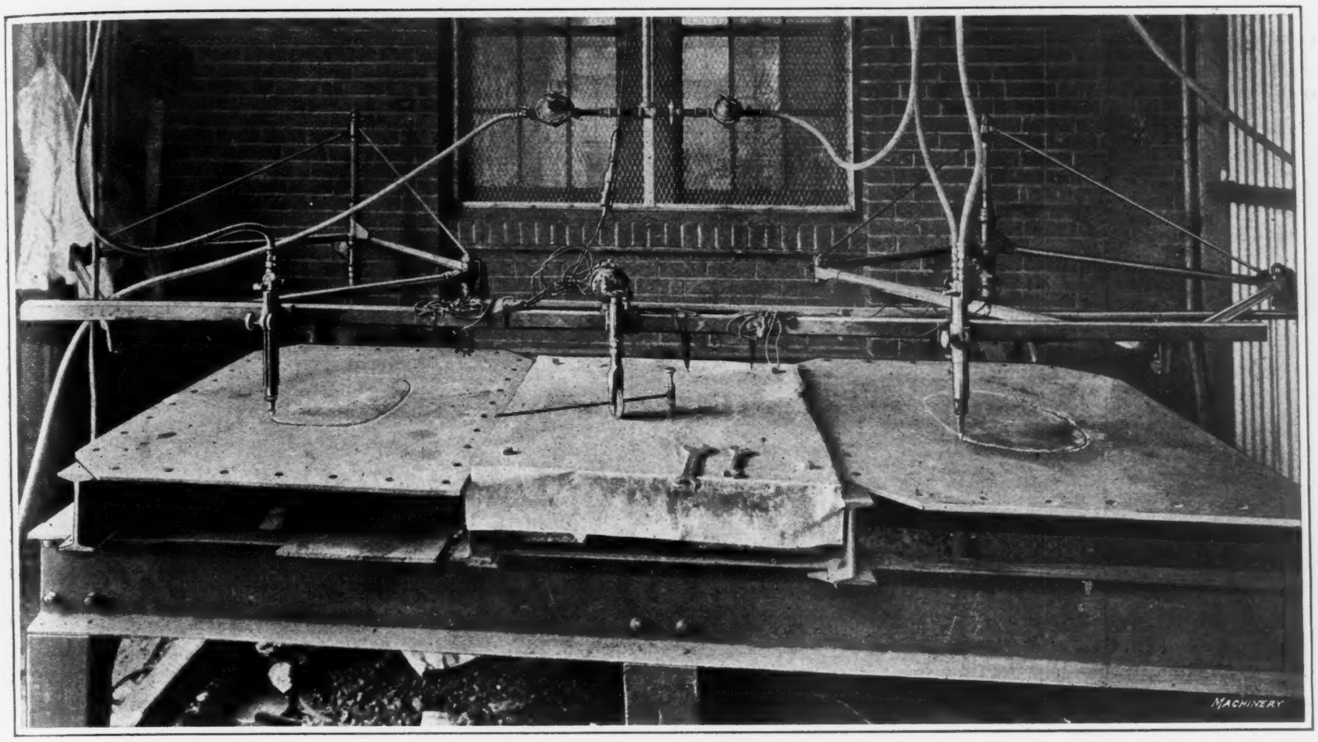

Fig. 9. Davis-Bournonville "Oxygraph" Machine equipped with One Tracing Point which runs over "Copy" and guides Two Cutting Torches over Similar Paths on Work

not made by one continuous traverse of the torch. In the case of the 24-inch armor plate, to which reference was made, the cut was finished at one operation. The composition of carbo-hydrogen gas is such that an accurate, clean cut is made, and the slag produced is almost pure oxide of iron, there being little pure iron in it. This indicates that cutting is accomplished by a complete process of oxidation, which is the ideal method, and not by melting the iron. Where metal is severed by melting, it is almost inevitable that a ragged surface will be left in making a cut, so that it is necessary to employ some subsequent process of finishing before the work is ready for use.

Machines Designed for Cutting Irregular Outlines

To facilitate the work of following irregular outlines with a cutting torch employed for working on flat metal plates, the Davis-Bournonville Co. has developed a machine known as the "oxygraph," which is made in two types, one of which is illustrated in Fig. 8, while the other is shown in operation in Fig. 9. So far as the principle of operation is concerned, both machines are the same, but it will be apparent from the illustrations that in one case provision is made for using a single torch for cutting one piece of work, while on the other machine the use of two torches enables two cuts to be made simultaneously. These machines work on the pantograph principle, and in preparing for their use it is first necessary to make a drawing of the outline which is to be followed by the cutting torch. This drawing is laid on a copy table on the machine and is followed by a tracing point carried by the pantograph, with the result that one or both torches—according to the type of oxygraph machine that is being used—follow a similar outline on the work.

Reference to the illustrations will show that the tracing point used on machines of this type consists of a wheel which is serrated to give it a firm grip on the surface of the paper on which the design is laid out, and this wheel is driven by a small electric motor, which relieves the operator of the machine from the necessity of pushing the tracing point around. As a result, it is merely necessary for this man to guide the tracing point so that it follows the required outline, thus adding greatly to the sensitiveness of the machine, because the operator is relieved of the necessity of pushing the tracing point and overcoming friction and inertia of the pantograph mechanism. Fig. 8 shows an example of quite an irregular outline which one of the single-torch type of machines was recently engaged in cutting, and this illustration gives a good idea of the irregularity of outlines which may readily be followed with a machine of this type. In Fig. 9 is shown one of the double-torch machines engaged in cutting a hole in steel ship plates at the plant of the Philadelphia Navy Yard. In this case the outline to be followed is fairly regular, but the use of a double-torch machine enables two plates to be cut simultaneously, which, combined with the superior rate of production of the mechanically operated torch over a cutting torch manipulated by hand, greatly increases the rate at which the cutting operation can be performed.

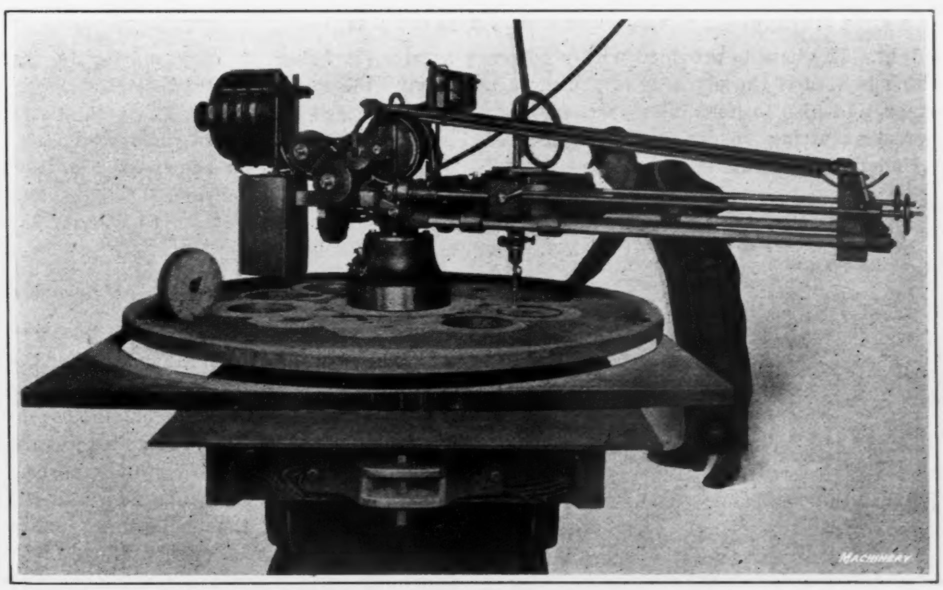

Fig. 10. Automatic Universal Cutting Machine developed for Use in Schenectady Plant of General Electric Co.

Special Cutting Machine Developed by General Electric Co.

In Figs. 10 and 11 are shown automatic universal cutting machines developed for use in the plant of the General Electric Co., in Schenectady, N. Y., which

employ either an oxy-acetylene or an oxy-hydric flame. The machine shown in Fig. 10 can be set for automatically making circular, spiral, radial, or tangential cuts, with a rate of feed ranging from 1 inch to 72 inches per minute, depending upon the character and thickness of the material to be cut. It has been successfully employed for cutting steel up to 16 inches thick, the limit in this direction being imposed by the capacity of the flame rather than by any limiting features of the machine. On this machine it will be seen that a revolving head is provided that can be adjusted for automatically feeding the torch in every direction, provision being made for reaching any point on a circle up to 20 inches in diameter, while cuts over larger surfaces are made by revolving the entire cutting machine or by reciprocal movement of the revolving head along the horizontal bars; in some cases a combination of these movements is required to obtain the desired result. Revolving the entire cutting machine or reciprocal movement of the revolving head along the main arms is accomplished by gearing connected to a driving motor, which will be seen mounted above the pedestal. This motor is a 250-volt, direct-current machine of 1/2-horsepower capacity, which happened to be available at the time the machine was built. As a matter of fact, a considerably smaller motor would give ample power for operating the machine.

Two rheostats are provided for obtaining speed control, and attention is called to the fact that the long radial arm is balanced by a counterweight. The base is provided with a powerful electromagnet, which is used if the machine is placed on a rough or uneven surface, and also to hold it in position when it is necessary to perform cutting operations on work held in a vertical plane. Under normal conditions of service with

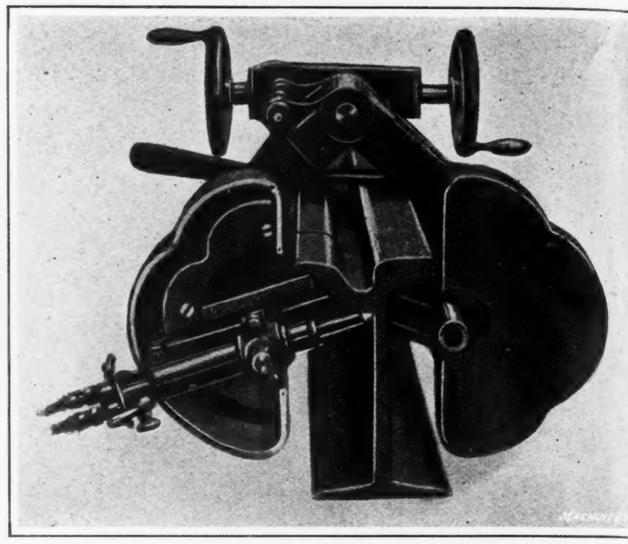

Fig. 13. "Railograph" Machine built by Davis-Bournonville Co. for cutting Rails in Place on Roadbed

the machine working on a horizontal plane, the magnet is not required, as the weight of the machine is sufficient to hold it in place. It will be apparent from the fact that the machine is shown in place on a truck that it is adapted for portable service, it being an easy matter to transport the machine around the shop, as it only weighs approximately 1900 pounds. The outfit shown in Fig. 11 is of similar design to the one which has just been described; it consists essentially of two of the machine units shown in Fig. 10 mounted on beds to provide a traverse movement. This double machine is ordinarily employed for work which is too large to be handled on a single machine.

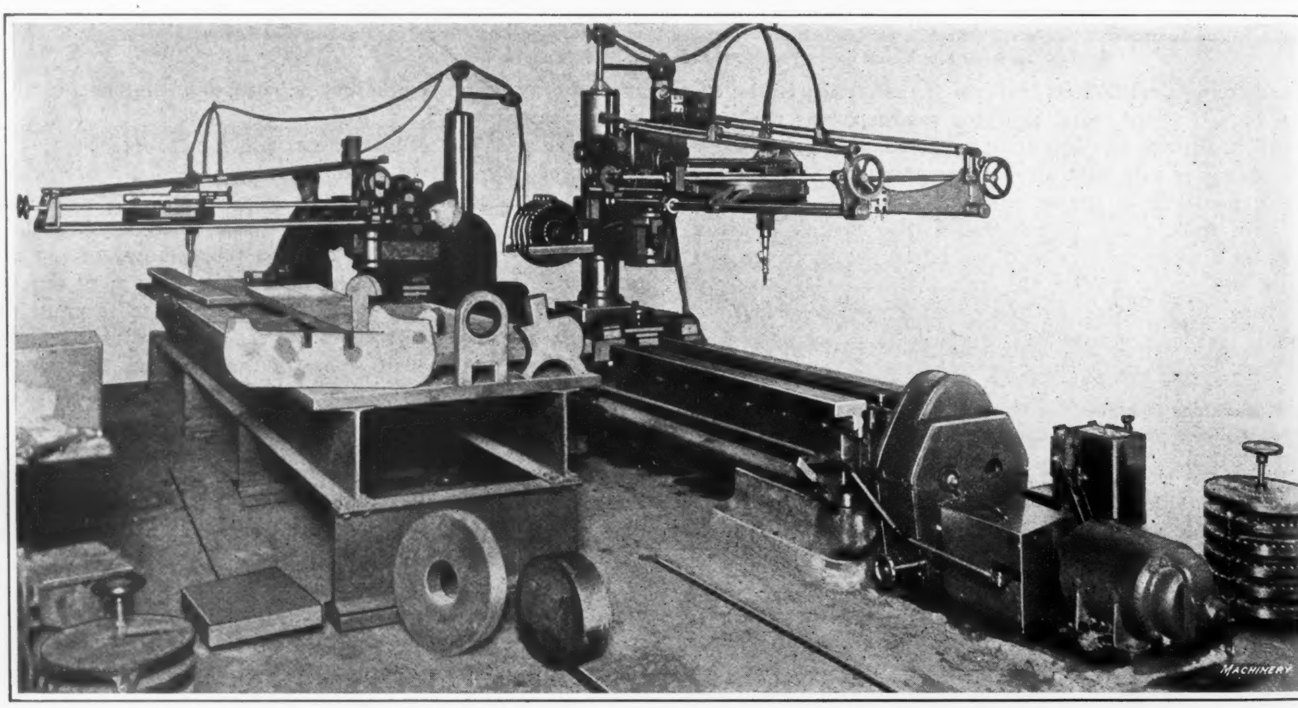

Fig. 11. Double-head Automatic Universal Cutting Machine mounted on Bed which affords Traverse Movement in Addition to Movements Available on Machine shown in Fig. 10

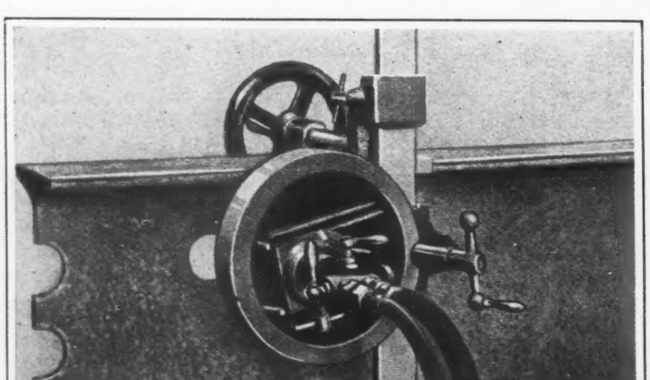

Fig. 12. "Holograph" built by Davis-Bournonville Co. for cutting Holes in Rail Webs, etc.

Special-purpose Mechanically Operated Cutting Torches

In the case of the mechanically operated cutting torches which have already been described, the design has been worked out in such a way that the machines are adapted for the performance of miscellaneous cutting operations. Such work, however, by no means represents the range of possibilities of the mechanically operated cutting torch. For instance, consider the case of equipments shown in Figs. 12 and 13, which show, respectively, the "holograph" and the "railograph" developed by the Davis-Bournonville Co. These machines were made for performing the special operations of cutting holes in the webs of structural steel rails, etc., and for cutting T-head rails. They give excellent results in performing these special

operations for which they are intended, but are not suitable for other classes of work.

Referring to the illustration of the holograph shown in Fig. 12, it will be seen that this machine is provided with a circular head which holds the cutting torch so that it can be rotated through movement transmitted by bevel gearing from a crank handle at the side of the machine. The capacity is for cutting work up to 3/4 inch in thickness, and round holes can be made with this machine without previous drilling. Smooth round holes from 1/2 to 2 inches in diameter can be cut in from thirty to sixty seconds, and the diameter of the hole is varied by simply shifting the torch holder toward or away from the center of the rotating head. This machine is especially adapted for railroad work and for enlarging existing holes or cutting new ones in structural steel.

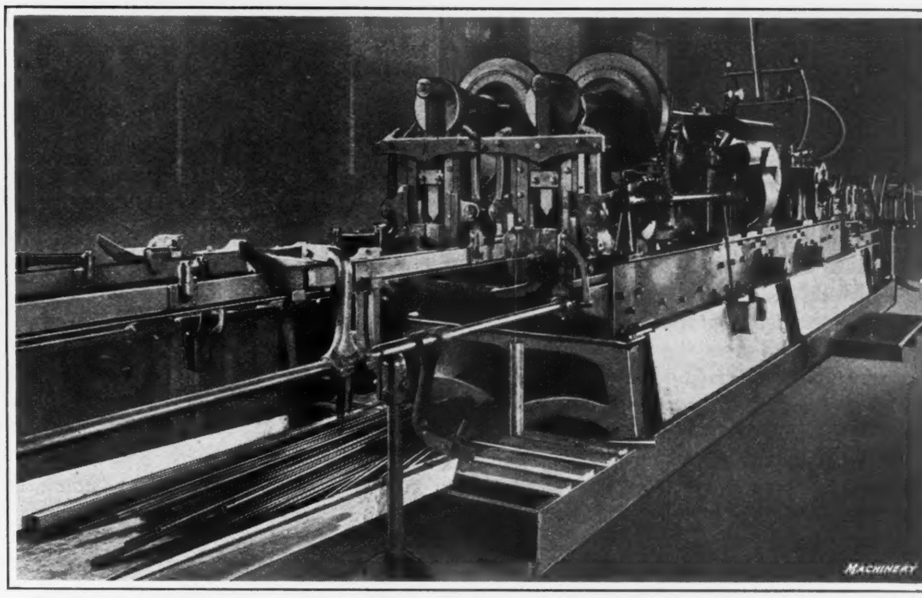

Fig. 18. Opposite End of Automatic Tube-making Machine shown in Fig. 17; Flat Stock is fed into Machine at End shown in Fig. 17 and Finished Welded Tubing is withdrawn from End of Machine shown in This Illustration

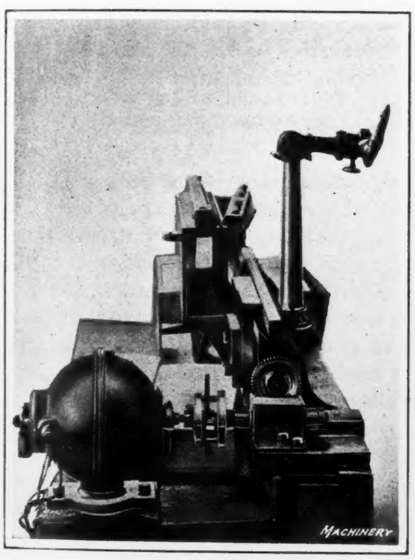

Fig. 14. Special Machine developed by Edison Storage Battery Co. for Use in welding Side Seams of Battery Containers

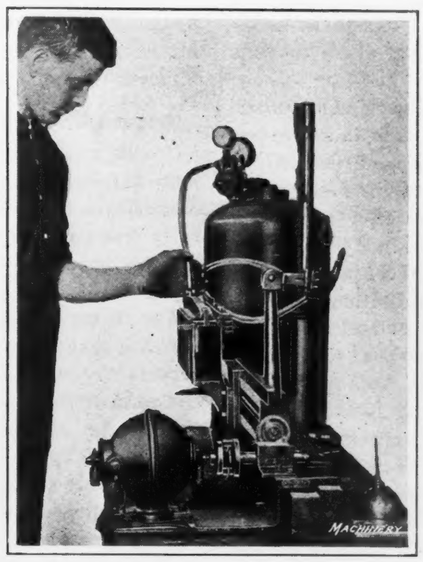

Fig. 15. Machine shown in Fig. 14 with Clamps closed to hold Work Ready for welding

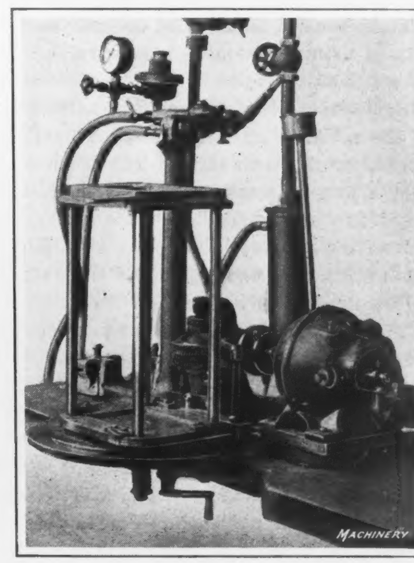

Fig. 16. Special Machine developed by Edison Storage Battery Co. for welding Top and Bottom into Battery Containers

In the case of the railograph illustrated in Fig. 13, it will be seen that provision is made for clamping this machine to the web of a rail. It can be used for cutting a rail while in position in the roadbed. At each side of the machine there is a bracket in which a cutting torch can be mounted. This bracket is carried by a slide, and attached to each bracket there is a roller which runs in contact with a cam formed in such a way that it provides for maintaining the tip of the cutting torch at a uniform distance of about 1/8 inch from the surface of the work as the torch is fed over the work to provide for cutting the rail. Feeding of the torches is accomplished by two handwheels which transmit motion through a set of suitable gearing. In operation, the torch is first applied at one side of the rail and fed over the line on which the cut is to be made, one half of the base and head of the rail and the web being cut in this way. The torch is next removed from the holder and mounted at the opposite side of the rail, where it is again passed over the line of cut, with the result that the remaining half of the base and head of the rail is severed. An idea of the rapidity with which cutting can be accomplished with this machine will be gathered from the fact that at a recent exhibition a 9-inch trac-

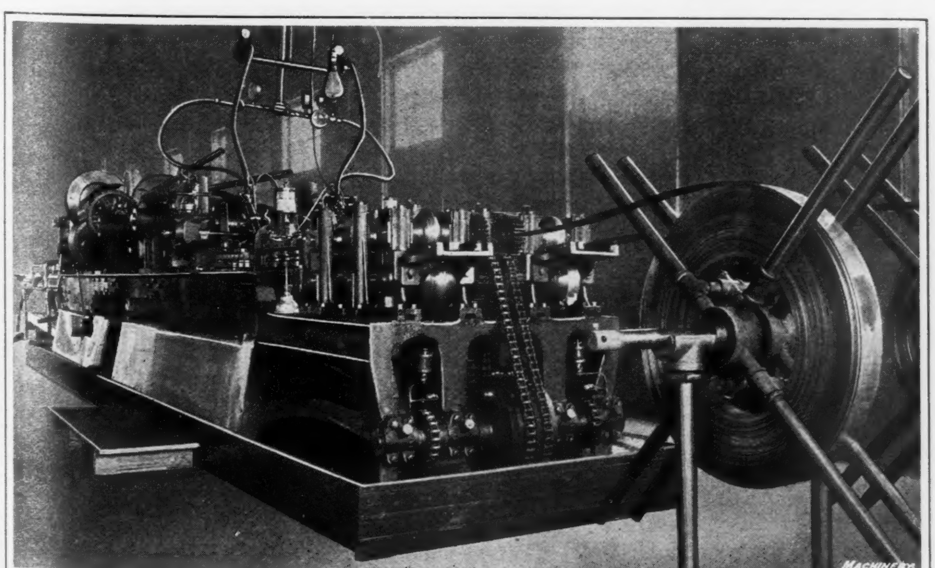

Fig. 17. Machine used by Elyria Iron & Steel Co., of Cleveland, Ohio, for Use in automatically converting Flat Steel Ribbon Stock into Welded Steel Tubing

tion rail was cut off in a few seconds over three minutes with the consumption of 2 cubic feet of acetylene and 5½ cubic feet of oxygen. A standard Davis-Bournonville cutting torch is used on this machine.

Special Welding Machines Used for Manufacturing Operations

In manufacturing sheet-steel battery containers, the Edison Storage Battery Co., of Orange, N. J., has designed special machines for welding the seams. It will be recalled that in connection with the discussion of special cutting machines, mention was made of the fact that it is usually found desirable to employ torches of standard design, and the same is true of machines built to meet the requirements of welding operations that must be performed on special classes of work. In the case of the battery container welding machines shown in Figs. 14, 15, and 16, Davis-Bournonville welding torches are employed. Figs. 14 and 15 show the machine employed for welding the side seam, and Fig. 16 shows a machine developed for welding the head into the container. An interesting feature of the application of welding torches in connection with these machines is that the welding is accomplished without the addition of metal from a "welding stick" according to the usual practice. To avoid the necessity for making such an addition of metal, the sheet-steel stampings which are welded together to make these battery containers are drawn up with flanges along the two edges that are to be welded together. By having these flanges raised above the surface of the steel, sufficient metal is provided to make the weld without the necessity of using a Swedish iron wire to add metal along the line where the weld is to be made.

For welding the side seam of battery containers, use is made of the machine shown in Figs. 14 and 15, which is somewhat similar to a bench lathe. The work to be welded is clamped over a form supported by a carriage, which is traversed along ways on the bed of the machine by means of a feed-screw driven by an individual electric motor. Welding of the side seam is the first operation, and the body of the container comes to the machine with neither the top nor the bottom in place. It is slipped over the form and two swinging clamps grip the work at each side of the longitudinal seam, so that the flanges are pressed close together. After this has been done, the pivoted bracket supporting the welding torch is swung over so that it causes the oxy-acetylene flame to impinge upon the top of the abutting flanges at one end of the container, and the drive is then connected to start feeding the carriage along the ways on the machine bed. The feed movement is regulated so that the work is passed under the torch at a suitable rate to provide for welding the side seam as rapidly as possible. These battery containers are made of cold-rolled sheet steel 0.025 inch in thickness.

After the side seam has been welded, the containers are taken to the machine shown in Fig. 16, where the bottom is welded into place. The bottom consists of a steel stamping with the flange turned up around the edge. It is pressed into place in the battery container body until the top of the flange is at the same level as the edge of the body, after which the work is set up in the machine. As in the case of the equipment for welding the side seam, the torch is mounted on a swinging support, so that it can be dropped into place to cause the flame to impinge upon the edges of the steel which are to be welded together. The machine is driven by an electric motor which transmits power through a suitable train of gearing to a pinion carried by a vertical shaft. This pinion meshes with a rack, which will be seen running all of the way around the base of the frame in which the work is supported while the welding operation is being performed.

From the illustration it will be apparent that this rack runs along the sides and around the corners of the base of the work-holder, so that provision is made for giving this holder a combined traverse and rotary movement that causes the work to be fed around under the welding torch, keeping the two edges that are to be welded together constantly in place under the tip of the torch. In the top of the battery container there are three fittings that have to be secured in holes provided in the steel stamping for that purpose. In making the stamping for the top of the container flanges are drawn up around the holes to receive these three fittings which are made on screw machines. In making the fittings, the screw machines are tooled up to produce a flange on each fitting which is of such form that the fittings can be pressed into place in the holes in the top of the battery container, with these flanges on the fittings abutting against the flanges around the holes in the container top, so that the edges are at the same height. A machine of somewhat similar design to the one shown in Fig. 16 is then employed to weld the edges of the flanges on the battery top and fittings together so that the fittings are secured in place. These welds are made on the under side of the top of the battery container, after which the entire top is pushed into position in the body of the container and welded to hold it permanently in place.

Application of Welding Torches in Tube Manufacture

At the plant of the Elyria Iron & Steel Co., in Cleveland, Ohio, welded tubing is manufactured in automatic machines which take flat ribbon stock of either hot- or cold-rolled steel from a reel placed at one end of the machine and deliver finished tubing at the opposite end of the machine. This result is accomplished by passing the stock through a series of forming rolls which convert the flat stock into a cylindrical form with the edges abutting against each other. The work is next fed under an autogenous welding torch which joins the seam, after which the welded tubing passes through straightening and polishing apparatus, so that it leaves the machine in a finished form. Fig. 17 shows the end of the machine at which flat ribbon stock is fed in, and in Fig. 18 finished tubing is shown leaving the machine.

Adaptability of Mechanical Control for Cutting and Welding Torches

In this article we have presented information concerning miscellaneous applications which have been made of mechanically operated cutting and welding torches, and attention has been called to the benefits that are secured through the substitution of mechanical control for hand operation. Despite the increased production and higher quality of workmanship that are secured through mechanical operation, many manufacturers are continuing to use torches which are moved over the work by hand. There is no denying that the latter method is capable of producing highly satisfactory results when torches are placed in the hands of skilled operators, but the average mechanic will frequently fail to produce good work until he has had a considerable amount of experience. For this reason, and also because higher rates of production are secured through mechanical operation than can be produced by the most skillful operators using torches by hand, it is well worth while for the manufacturer who has use for the oxy-acetylene torch to carefully investigate the requirements of his work with the idea of determining whether it could not be handled by one of the standard cutting or welding machines. If investigation shows that the work could not be handled on any of the available commercial equipments, the next step is to ascertain whether a special machine using standard torches could not be developed at a reasonable expense. If so, development of such an equipment will usually prove a highly profitable investment, both from the standpoint of direct earnings and also by making an improvement in the quality of workmanship where cutting or welding operations have to be performed.

* * *

A maker of hollow-frame micrometer calipers designed for measuring large dimensions tried in vain for several years to introduce them to United States Government navy yards and arsenals. He was unable to secure recognition, but foreign governments were not so conservative in their views of measuring instruments, and some were sold abroad. These came to the attention of our military experts in France, and the result was that the maker has received orders for his large micrometers for use in government plants here. It seemed necessary for the bureaucratic mind to go far afield to get indorsement of a home product before it could see the manifest advantages of the instruments for our own government work.

PURPOSE AND METHODS OF USING MANUFACTURING ORDERS

BY FRED H. KORFF[1]

There always has been misunderstanding among factory executives and the clerical force relative to the manner in which orders are to be handled, especially when the items on the orders are in standard crates or containers. They do not seem to realize that an order entering the factory represents dollars and cents in raw material and should be treated as such. The greatest difficulty generally is for them to realize that the amount of material called for on the order, whether in pounds, feet, or pieces, is constantly changing. For instance, one hundred feet of bar stock is delivered to an automatic screw machine to have certain operations performed that will produce one thousand pieces; but some of the pieces will be rejected by the inspectors and others will be spoiled in the machine, so that, perhaps, only seven hundred good pieces will be made. The foreman of the department should immediately bring this fact to the attention of the chief cost clerk in order that the amount on the factory order and the office records may be changed to show seven hundred pieces instead of one thousand. If this is not done, the cost department will assume that one thousand pieces are in production throughout the succeeding departments and all labor costs per piece will be figured 30 per cent too low, due to the loss of the three hundred pieces on the first operation. Factory executives should realize that while production is an essential factor, the proper recording, checking, and transferring of both material and orders is as important a factor, and one that cannot be overlooked if accurate records are to be obtained. The argument may be advanced that factory executives are not supposed to be bookkeepers; but that does not signify that during the time that orders and material are in a department they cannot be properly taken care of; unfortunately, however, shop orders are generally treated as something of small consequence.

Use of Order

A shop order is used for the following purposes: First, checking advancement of work, as shown by the planning board; second, requesting orders from order department; third, checking material on hand and called for by previous shop orders; fourth, issuing material to cover the needs of respective departments. When the planning board shows that the work, in its progress through the various departments, is reaching the shortage danger point, requests for orders are issued by the planning office. The order division, upon receiving this request, checks the material called for against the stock on hand and on the different order lists, to determine whether or not the order can be filled; if it can, the material is sent to the department to which it is routed. It will be assumed that the order request calls for one hundred camshafts. As the order department finds that it has sufficient rough camshafts to fill the shortage called for, it immediately issues triplicate orders, which are sent to the planning office. At the proper time, as shown by the shop schedule list compiled from the trial records, the planning office sends one copy to the materials department and one to the cost department, and keeps the other for its own files. The materials department, on receiving the factory order, delivers the material with the order to the department called for by the routing shown on the order. The cost and dispatching departments enter their copies in their files preparatory to receiving data from the factory relative to the work that is being done.

Checking Material

When the material, with the order, enters a department, the clerk should immediately enter a full description of it upon the departmental progress or receipt report. All finished pieces and outgoing deliveries from the department should also be recorded upon this report, which at the end of each day should be given to the planning department and entered upon its records. As it is from these records that all shortage lists are made, it is important that they be accurately kept, so that correct records of shortages may be obtained.

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The clerk should also see that all incoming material corresponds to the amount shown on the order; if it does not, he should return the material to the department from which it came. The amount of material in the containers should be that shown on the face of the order, and all bar stock received should be measured. All outgoing material also must correspond to the amount shown on the order. If the amounts do not agree, the orders should be given to the planning department so that the necessary changes may be made. Clerks should not permit an order to leave the department until it has been signed by an inspector, who will specify the number of pieces accepted, rejected, and held for correction.

Use of Containers

As far as possible, all material should be sent into the factory from the materials department in crates of a standard size, and the work should remain in these crates as it progresses from one department to another. While in some cases this cannot be done, every effort should be made, if possible, to provide ways and means to prevent the moving of material by separate pieces. In order that the manufacturing orders shall be kept correctly, each container should bear a tag showing the order or job number, piece, part number and name, total amount on order, and the amount in the container to which the tags are attached. Cards specifying the job number, operation, piece number, and name of part should also be placed at each machine. This card should correspond to the tag attached to the container that holds the work being machined.

There should never be more than two orders at any one machine—one order in process of machining and the other waiting to be machined. Suppose, for example, that there are two orders of camshafts, composed of five crates each, at the machine performing the first operation. As the operator finishes a camshaft he replaces it in the crate from which he obtained it and proceeds with another until all in that crate have been machined. If necessary, this crate can then be passed on to the succeeding operation, but separate pieces should never be taken from a container and placed into operation on another machine; in fact, it is preferable that only a complete order be moved from one operation to another.

If, during the different machining operations, a piece is rejected by an inspector, it should be properly tagged by him and set aside, but should not proceed with the container from which it was taken; neither should the spaces thus left vacant in the containers be filled with good parts. When a part has been rejected by an inspector, he should make the necessary notations on the back of the order representing the part, and as the container proceeds from one operation to another he should note on the order the number of good and bad pieces obtained. After the final operation, prior to transferring from the department, the clerk should bring the order and the parts to the inspector for his approval.

* * *

IRON ORE PRODUCTION IN 1917

From figures compiled by the United States geological survey, it is estimated that the iron ore mined in this country last year amounted to 75,324,000 gross tons, as compared with 75,167,672 tons in 1916. The shipments from mines in 1917 are estimated at 75,649,000 gross tons, valued at $236,178,000, as compared with 77,870,553 tons, valued at $181,902,277, the previous year. The percentage lost in quantity last year was 2.9, but the increase in value was 29.8 per cent. The general average value of the ore per ton at the mines was $3.12 in 1917, as compared with $2.34 in 1916. About 85 per cent of the ore mined last year was received from the Lake Superior district. The South mined and shipped more than 8,100,000 tons of iron ore, the bulk of which was produced in the Birmingham district of Alabama. The northeastern states, including New Jersey, New York, and Pennsylvania, increased their production slightly as compared with 1916, and shipped to blast furnaces approximately 2,446,000 tons. The imports for the year are estimated at 988,500 tons, as compared with 1,325,736 tons in 1916.

EXAMPLE OF PRECISION GAGE MAKING

METHODS OF MAKING AND TESTING A GAGE REQUIRING UNUSUAL ACCURACY

THE manufacturers of precision gaging tools and fixtures are constantly being reminded of the fact that it is easy to specify extremely close limits on drawings, but often very difficult to transfer those exact dimensions to a piece of steel. The gear-testing fixture or gage illustrated in Fig. 1 is an example of gage making which required an unusual degree of accuracy throughout and made it necessary to provide special tools and methods. This gage is one of a number of special designs recently made by the Nelson Tool Co., Inc., 781 E. 142nd St., New York City. Some of the more important parts of the work will be referred to, but first it should be explained that this gage is used for testing the accuracy of the bevel gears *A* and *B*. As the axes of these gears are located at right angles, the body *C* of the fixture is in the form of an angle-plate in which there are horizontal and vertical holes.

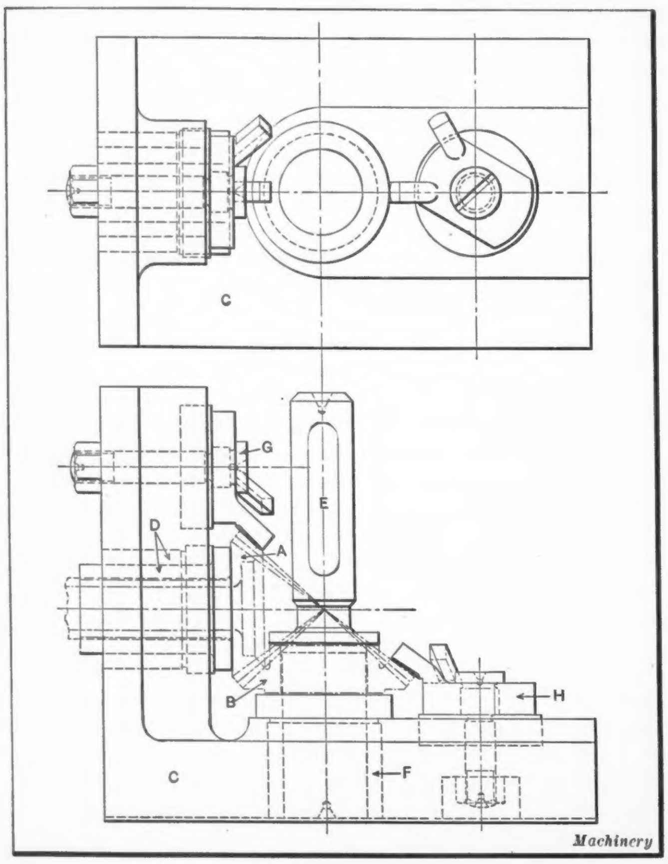


Fig. 1. Elevation and Plan of Gear-testing Fixture

Gear *A* is supported in close-fitting bushings *D* by its shaft, and gear *B* is held in place by plug *E*, which enters bushing *F*. The gaging members consist of two blocks *G* and *H*, which are held in position by the bolts shown and are free to revolve. Each of these gaging blocks has two arms which project outward at an angle. If the gears are correctly made, one of these arms will just clear the top of a gear tooth when the gage is turned about its pivot, whereas the other will strike the tooth. In other words, these are "Go" and "Not Go" arms; they are both finished, of course, to the same angle, but one gaging surface is about 0.006 inch higher than the other one.

The angle specified on the drawing for the gaging surfaces of the arms of part *H* is 36 degrees 8 minutes 33 seconds, and for part *G* 46 degrees 31 minutes 53 seconds. Of course, there is no gage or toolmaking equipment obtainable that will enable one to finish angular surfaces to the extreme degree of accuracy indicated by these figures; that is, to a given angle within one second or even several seconds, especially when the length of the finished surface is comparatively short and its accuracy must be tested by direct measurements and without employing some method of magnifying the error. To detect an error of

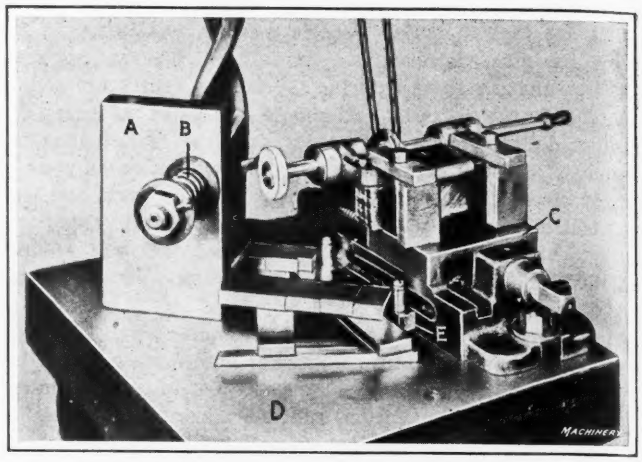


Fig. 2. Method of using Johansson Gages and Sine Bar for setting Grinding Attachment

one second in a length of one-half inch, which is approximately the length of the gaging arms, would involve a measurement of about 0.0000025 inch. It is not necessary to comment on the impracticability of taking such a measurement, but even though it is not possible to work to such close specifications, if the error is so slight that it cannot be measured by ordinary means, the work is sure to pass inspection and to serve its intended purpose satisfactorily, which is all that is required. In addition to the extreme accuracy in regard to the angles, it was necessary to finish the body of the fixture previously referred to so that the horizontal and vertical sides were as near square as it was possible to make them, and the tolerances specified for a number of the more important dimensions were only 0.0001 and 0.0002 inch.

The most interesting and important part of the work is grinding the angular arms of the gaging blocks. The general method of doing this part of the work is illustrated in Figs. 2 and 3. The block to be ground is mounted on an angle-plate *A*, Fig. 2, and it is held in position by a bolt and a spring *B*. The object of using the spring is to hold the work securely against the face of the angle-plate and at the same time permit it to be revolved easily while grinding. The grinding attachment, which is of the push-spindle type, is mounted upon a horizontal slide *C*, and both the angle-plate and slide are mounted on the faceplate *D*.

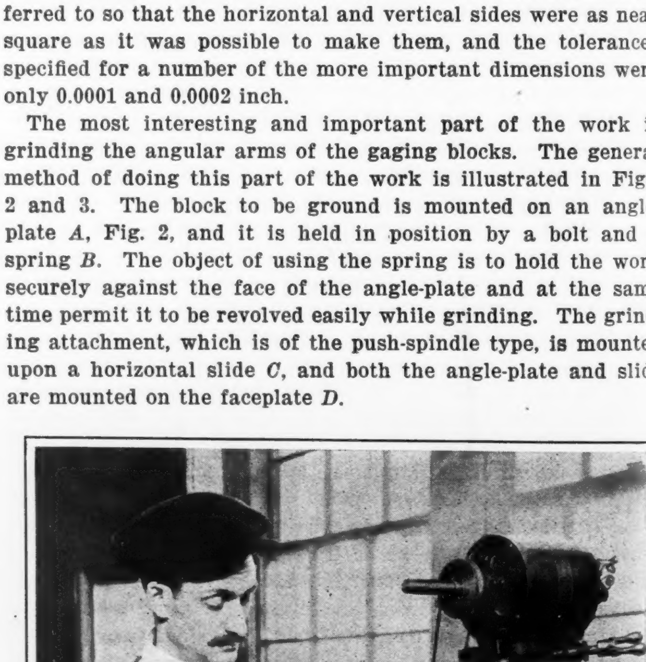


Fig. 3. Simple Method of grinding Gaging Blocks which proved Effective

The grinding of this gaging block involved first setting the horizontal slide and the angle-plate with reference to the angle required on the work; then it was necessary to adopt an accurate method of testing the inclination and location of this ground surface. Fig. 2 shows clearly how the slide and angle-plate were set relative to each other by using the sine bar *E* and the Johansson gages. The sine bar bears directly against the side of the horizontal slide upon which the grinding attachment is mounted, and the gages are used to measure the distance from the buttons on the sine bar over to the side of the angle-plate. The method of manipulating the grinding attachment and work is indicated in Fig. 3. As the gage-maker pushes the grinding wheel spindle back and forth with the right hand, he gives the work an oscillating movement, so that the entire gaging surface is ground and is finished to a convex form. The motor for driving the spindle is held in place by the vertical arm shown, and the entire arrangement is very simple, especially in view of the complicated nature of the operation.

The method of testing the angle and location of these ground surfaces is illustrated in Fig. 4. This test is made without removing the gage from the grinding fixture. The particular gage arm to be tested is simply turned around so that it is at the lowest position, as Fig. 3 indicates. Johansson gage-blocks are then inserted at *A* and *B*, and an accurate plug is pushed in between the horizontal and vertical surfaces of these blocks and the angular surface of the gage being tested. When this test has been made with the plug bearing close to the outer end of the angular arm, a different combination of gage-blocks is used and the same test is repeated at the inner end of the arm. Before this test could be made, it was necessary, of course, to calculate what the horizontal and vertical distances, as obtained by the Johansson gages, should be for a plug of given diameter.

Since the accuracy of the gear-testing fixture referred to depends largely upon the accuracy of the body of the fixture, it was necessary to adopt some method of testing the squareness of the horizontal and vertical faces, which were required to be as close as possible to 90 degrees. The ingenious form of "square" used for this purpose is illustrated in Fig. 5. This is simply a very accurate cylinder, having bearing surfaces at the ends which are exactly perpendicular to the axis of the cylinder. This "cylindrical square" is made of machine steel and is pack-hardened. It is bored out to decrease the weight somewhat, although a fairly heavy cylinder is preferable, so that it will not move or change its position easily when measurements are being taken from the cylindrical surface to an angle-plate, as is sometimes desirable. Each end of the "square" is recessed so that the bearing surface is only about 1/4 inch wide. This bearing surface is also ground slightly

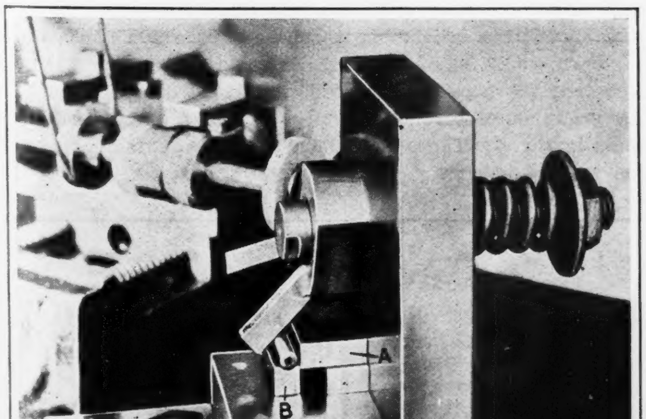


Fig. 4. Method of testing Accuracy of Ground Surfaces

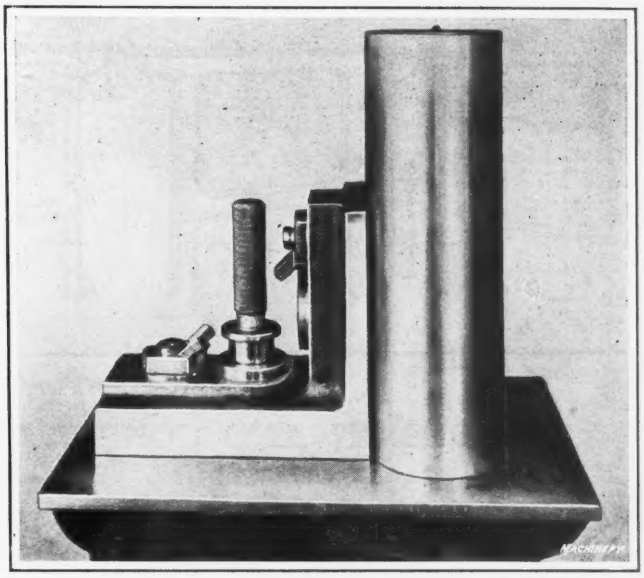


Fig. 5. Cylindrical Type of Precision "Square" used for testing Squareness of Fixture Body

concave so that the bearing is around the outer edge or circumference. When this "cylindrical square" is placed in contact with a surface as shown in the illustration, even a slight deviation from the vertical will be indicated by the passage of light. F. D. J.

* * *

STANDARDIZATION OF SCREW THREADS

The complete standardization of screw threads necessary to meet the requirements of the War and Navy Departments is proposed in a bill recently introduced in the House of Representatives by Hon. John Q. Tilson, of Connecticut. This bill provides for the appointment of a commission of seven members, which is to include a commissioned officer of the Army, a commissioned officer of the Navy, the director of the Bureau of Standards, two members nominated by the American Society of Mechanical Engineers, and two members nominated by the Society of Automotive Engineers, the last four being appointed by the Secretary of Commerce. This commission will ascertain and establish standards for screw threads, which will be submitted to the Secretaries of War, Navy, and Commerce. When approved by them, such standards will be used on work done by the War and Navy Departments, and the Secretary of Commerce will cause them to be published as a public document.

In urging the passage of this bill, Chairman Bachman of the Standards Committee of the Society of Automotive Engineers mentioned that if such standards had been established prior to the entry of the United States in the present war, an untold saving in time and material would have resulted; much confusion now existing would never have occurred, and instead of each department of the Government employing screw threads made under as many different systems, all would be working to one standard. A large duplication of effort would thus be eliminated and the production of tools and gages necessary to manufacture and inspect properly parts containing screw threads would be considerably conserved.

* * *

At a joint meeting of the Institute of Bankers and the Association of Chambers of Commerce in Great Britain, a resolution was passed with relation to decimal coinage, favoring the retention of the pound sterling as the monetary unit, but dividing the pound into one thousand parts or mils. This arrangement would make unnecessary any sudden change in the existing silver and gold coins, as all coins down to sixpence could be retained without any alteration in their respective values. A sixpence coin would equal twenty-five mils and a shilling would be fifty mils. In regard to coins of lower denomination, it was unanimously agreed to recommend that they should consist of one-, two-, three- and four-mil pieces made from copper, and five- and ten-mil pieces made from nickel.

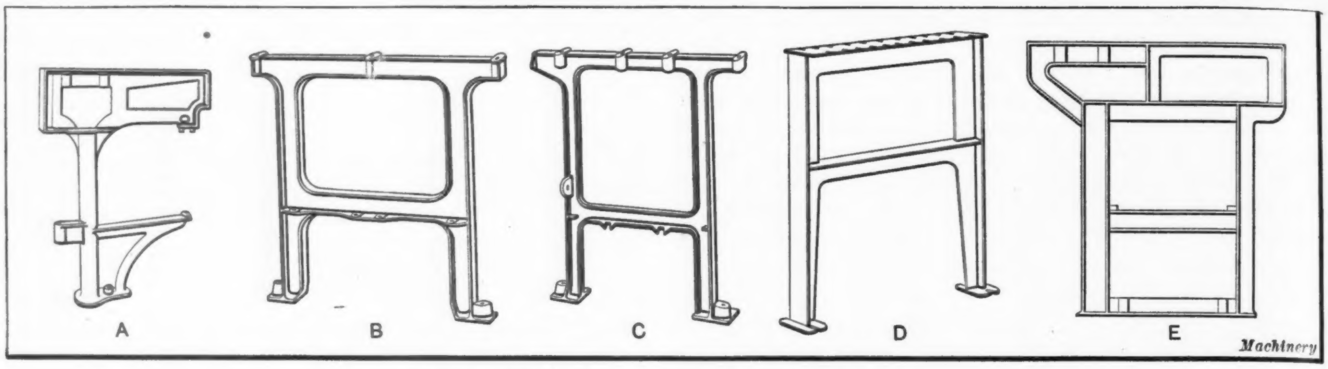


Fig. 1. Various Designs of Commercial Cast-iron Bench Legs

DESIGN AND CONSTRUCTION OF WORK-BENCHES

BENCH LEGS AND TOPS—LOCATION OF BENCHES—PORTABLE WORK-BENCHES

BY FRANK H. MAYOH[1]

BENCHES made in a workmanlike manner for the proper performance of hand and machine operations are a necessity in the modern shop. This fact will be realized when we consider the miles of benches that are strung along the walls and throughout our factories for use in conjunction with such work as filing and scraping, assembling, inspection, and numerous other jobs of machine shop practice that must be performed by hand. The purpose of a work-bench is to provide suitable means for performing hand or machine operations at a convenient height, this height depending upon such conditions as the nature of the work, the height of the man (and lately of the woman) using it, the kind and size of the machine placed upon it, in case the bench is intended for machines, and whether the work operated upon is to be held in a vise. These and many other conditions—some of which will be referred to later—have been taken into consideration in developing work-shop benches.

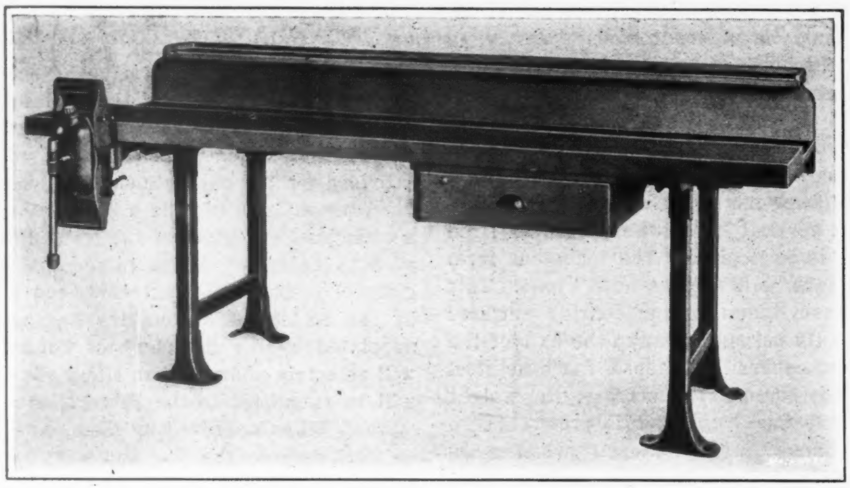


Fig. 2. Bench for Patternmakers built by New Britain Machine Co.

In the selection of a suitable bench for any particular purpose there is considerable latitude, but of recent years haphazard methods of selecting machine shop material, in general, have come to be looked upon with disfavor; consequently we find that in selecting suitable benches, light weight with rigidity, strength but not bulk, the proper kind of planking, sanitation, and movability without destruction are all points which are worth considering, while, of course, the construction of the top of the bench has much to do with its durability.

Bench Legs or Supports

In some shops wooden posts are to be found as supports for work-benches, but the modern cast-iron and pressed steel legs are preferable. It is not the intention of the writer to place one kind of metal support before the other, as there are good and bad designs of both, while the lines of construction are closely allied. An example of good design is shown in Fig. 2. This illustration shows a complete unit supported on two legs for patternmakers' use. In this case, the legs are of pressed steel, the formed sections being electrically welded together. The top and back-board are made of wood, and a patternmaker's vise is shown at the left-hand end of the bench. This bench may be made in a unit, as shown, or it may be extended indefinitely. It will be noticed that the back-board is constructed with a shelf on top.

A group of cast-iron bench legs of varied design is illustrated in Fig. 1. These are typical of the general line of cast-iron legs. Some are cast in I-section and some in T-section.

[1]Address: 87 Samuel Ave., Pawtucket, R. I.

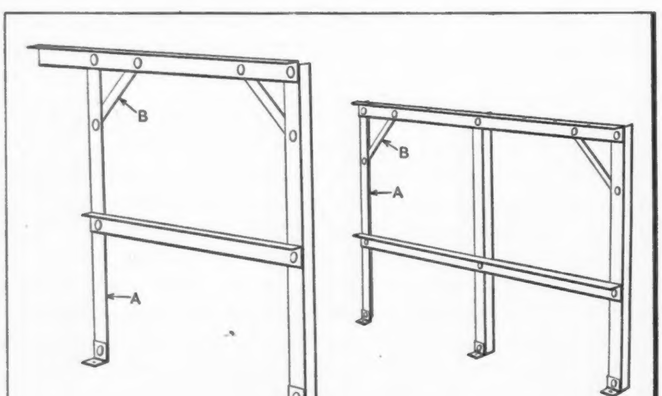


Fig. 3. Bench Legs in Single and Double Types made of Angle-iron

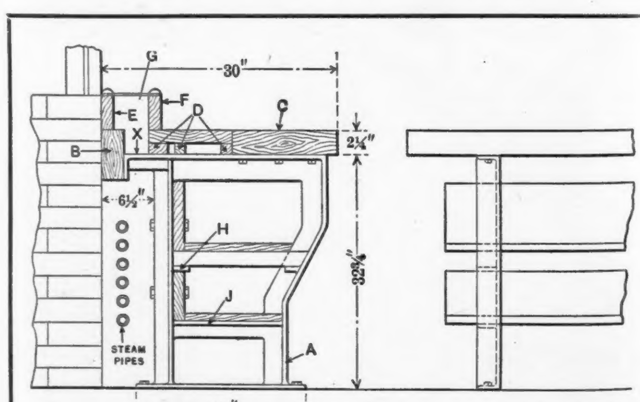


Fig. 4. Method of holding Bench shown in Fig. 6 in Position

The one shown at *A* is of the tubular stand or pedestal type. The one illustrated at *B* is a double-width type and is similar in construction to that shown at *C*. The design illustrated at *D* has a number of bolt holes through the flange, while the other legs shown have bosses through which the bolts go. Bench legs built of angle-iron are illustrated in Fig. 3. The one shown to the left is of the single-width type, while that

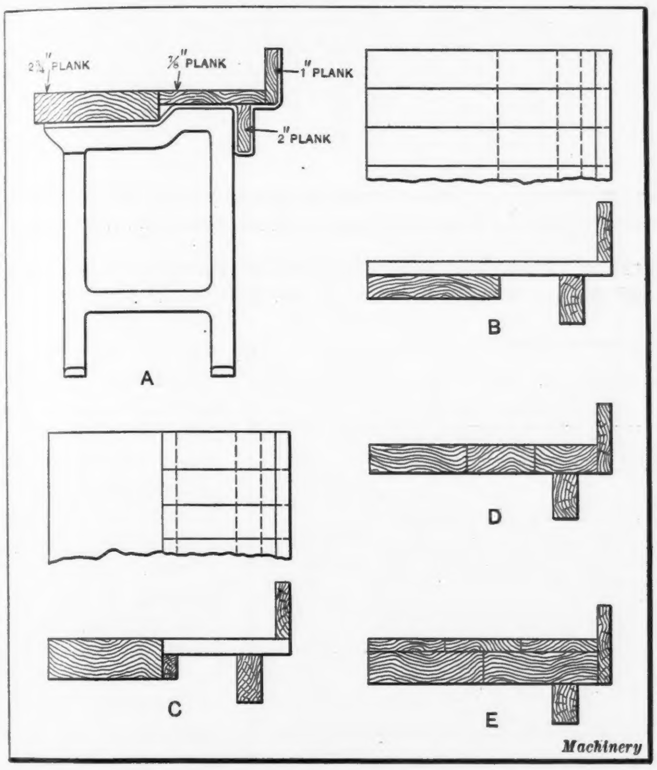


Fig. 5. Different Methods of constructing Tops of Work-benches

to the right is a double-width design. There are two angle-iron supports *A* in the single-width leg and three in the double-width type. A cross-piece is bolted on the top, and there is another piece (or two in some cases) part way down the leg, which act as braces and also serve for holding shelves. Additional strips *B* are bolted across the corners for increasing the stiffness.

In regard to wooden bench legs, apart from being bulky and combustible, it is almost impossible to make them so they

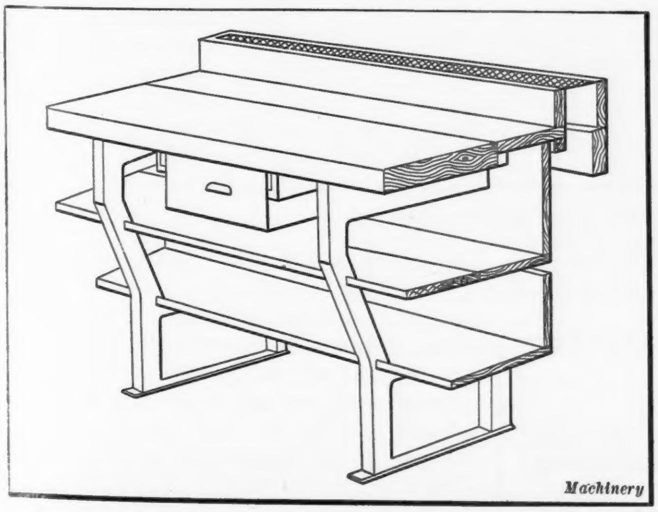


Fig. 6. Perspective View, showing Section of Work-bench with Air Space at Rear

will hold their shape, owing to the difficulty of getting wood that is well seasoned or dry enough, as even when carefully jointed it will shrink and leave the bench shaky; besides, good wooden joints are expensive to make.

The Bench Top

Metal tops for benches have been used to some extent, but in the handling of tools on a metal bench these are often injured by contact with the hard surface and wood is gen-

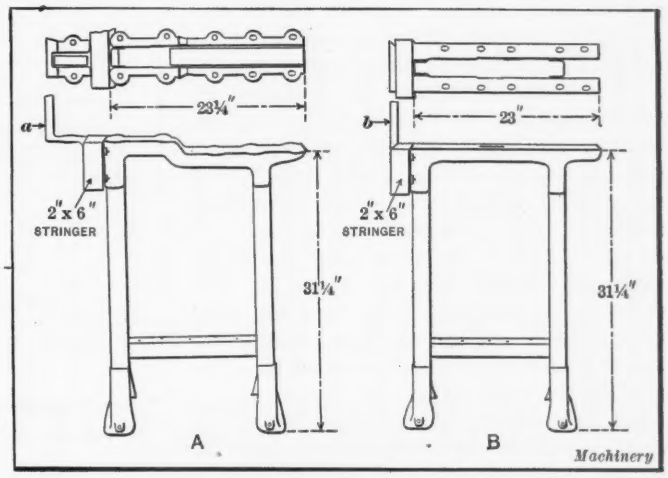


Fig. 7. Steel Bench Legs with (A) Angle Bracket for Back-board and (B) Straight Bracket for Back-board

erally used. A wooden bench top should be laid close to avoid cracks through which small parts might drop, with proper regard for shrinkage of the planks, and should be so laid as to avoid splintering when sliding work on and off. In Fig. 5, five forms of bench top construction are illustrated. In the upper view at *A* a bench with heavy 2¾-inch plank at the front and ⅞-inch plank in the rear is shown; both of these planks run lengthwise of the bench. At *B* is shown a construction in which it is planned to have the grain of the wood run from front to back. The bench top at *C* has a thick plank

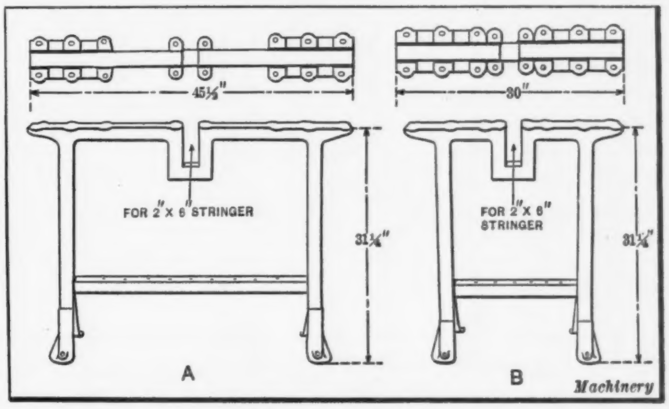


Fig. 8. (A) Wide Double Type of Pressed Steel Bench Leg. (B) Narrow Double Type

at the front running lengthwise of the bench, with short cross-boards at the back. In these three examples the expense entailed by having heavy planking throughout is avoided, which is an important consideration in view of the present prices of lumber. For some classes of work a heavy bench top is necessary. The bench top illustrated at *D* is built up with 2¾-inch planks running the full length and width. Where heavy, rough work is being continually dragged over a bench, the expense of keeping an ordinary top in repair becomes an im-

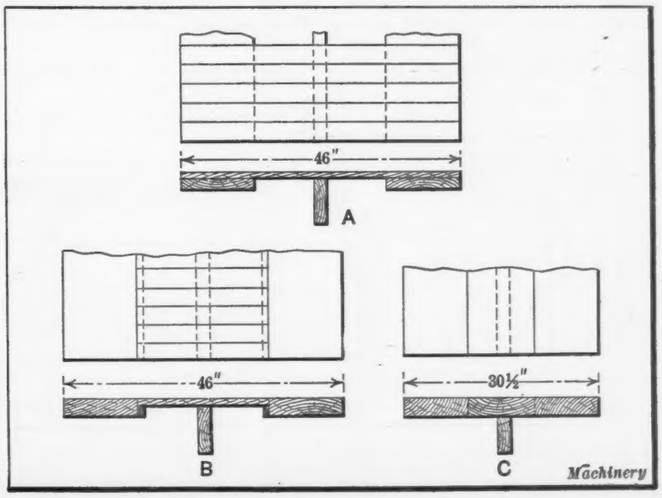


Fig. 9. Three Forms of Bench Tops for Use with Pressed Steel Legs Illustrated in Fig. 8

portant item, and this expense can be considerably reduced by constructing it as shown at E, although the first cost is greater. In this construction, two heavy planks extend lengthwise of the bench, and on top of these, running either lengthwise or crosswise, ⅞-inch planks are placed. This ⅞-inch top can be planed down when it becomes rough, or it may be taken up and replaced at small cost as compared with the heavy planking. When the bench top is constructed in this way it can be made quite free from cracks, as the thin boards are usually more thoroughly seasoned than the planks; therefore, the planks will shrink more than the top boards and draw the latter together. When the top boards are placed crosswise of the bench with the end grain showing there is the objection that they may be readily chipped; nevertheless, where local wear occurs, the boards when set in this way are most easily replaced. In regard to lumber used for the bench, maple or ash has been found to be suitable for the thick front plank, with ⅞-inch pine stock at the back and for the shelves. Spruce or hemlock is suitable for the back-board and other incidentals.

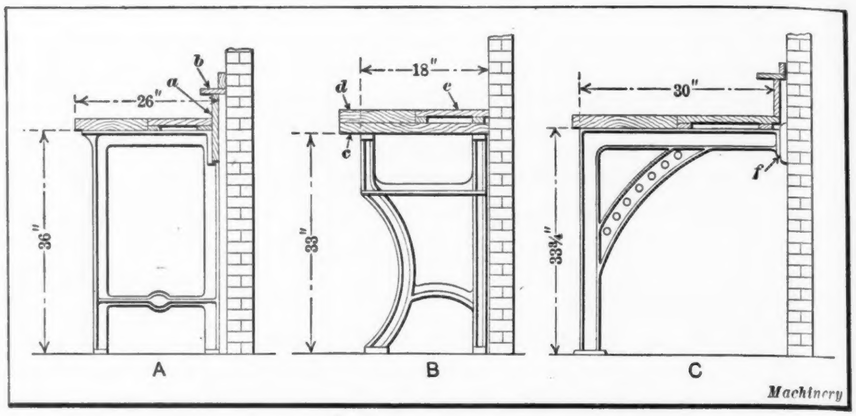


Fig. 11. (A) Bench of Straight-leg Type. (B) Curved-leg Type. (C) Angle-iron Type

Location of Benches and General Features

The best method of locating a bench is to set it away from the wall, so that, in case of fire, water from the sprinklers can get around it; this location also allows the heat from the steam pipes to rise, and leaves a convenient space where gas and air pipes may be placed. Fig. 6 illustrates a bench set up in this manner. Thick plank is used at the front and ⅞-inch plank at the back. There are two shelves beneath the bench and a drawer. An extension X, Fig. 4, holds it away from the wall, and the bench leg A is bolted to the floor. A plank B extends along the wall or suitable blocks are bolted in place where the legs come, the latter usually being about six feet apart with this type of leg. To plank B the back of the bench leg is bolted. Three bolts securely hold the legs in position (two in the floor and one in the wall), and after leveling all the legs in a row, the heavy plank C is bolted in position. The three strips D are next put in place and the back plank is placed on top of these, wire nails and screws being used for holding it in place. This completes the top of the bench. The board E is now placed in position on the wall and the back-board F attached. The wire mesh G is next stretched over the two boards E and F and is securely held in place by nails. This prevents things from being thrown or dropped down back of the bench, but it does not interfere in any way with proper ventilation or lessen the fire protection. Two sets of lugs H and J are cast on the legs and may be used for building either one or two shelves under the bench by placing boards on them in the manner shown. If the back-boards used in connection with the shelves on these legs are made to drive between the lugs, they provide additional stiffness for the entire bench.

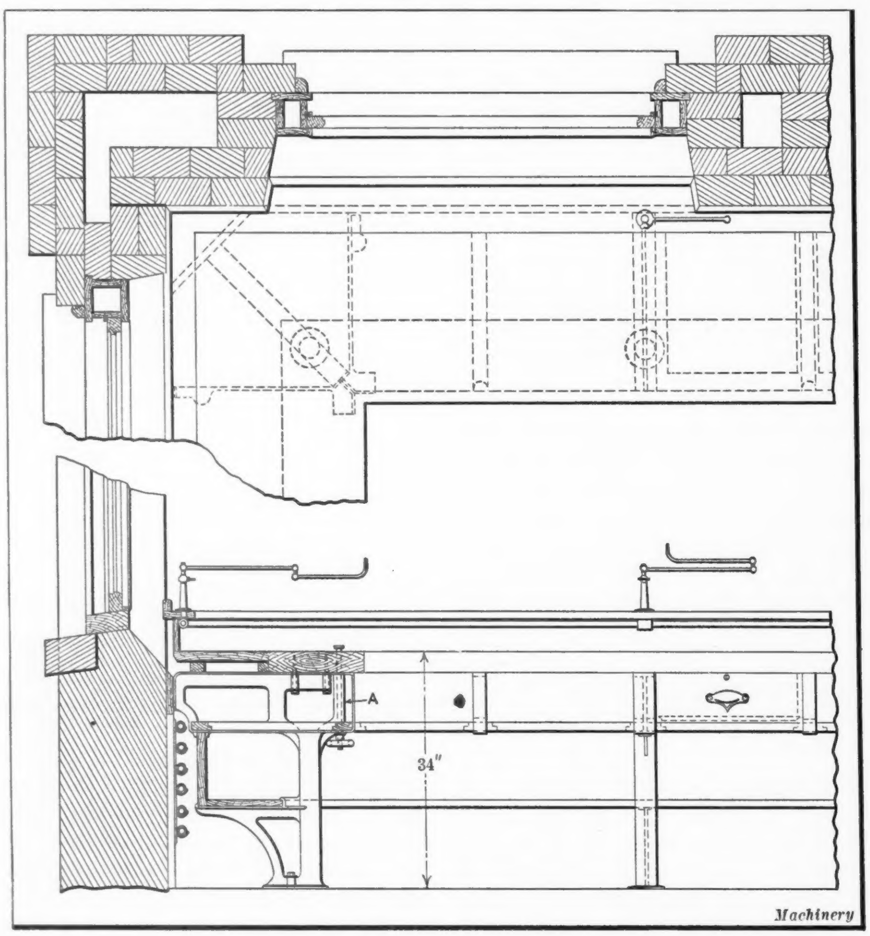


Fig. 12. Elevation and Plan illustrating Corner Construction of Work-bench

The foregoing remarks concerning bench tops apply whether using bench legs made of cast iron or of steel. Examples of the latter type, made by the New Britain Machine Co., are illustrated in Fig. 7. The leg shown at A has a step of 1½ inch at the top to allow a thick plank to be used in front with a thin one at the back without building up the back-plank as shown in Fig. 6. An angle-iron a, Fig. 7, is bolted to a 2- by

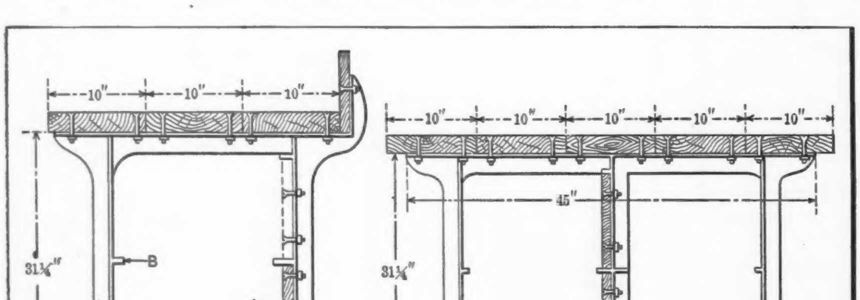


Fig. 10. Sections of Single- and Double-width Benches equipped with Cast-iron Legs

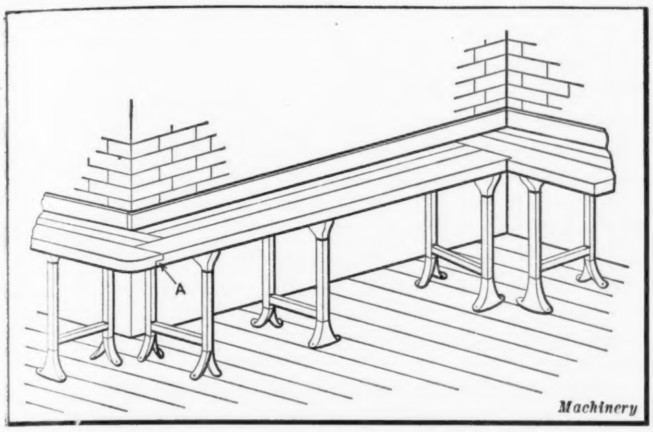


Fig. 13. Another Method of constructing a Work-bench at Corners

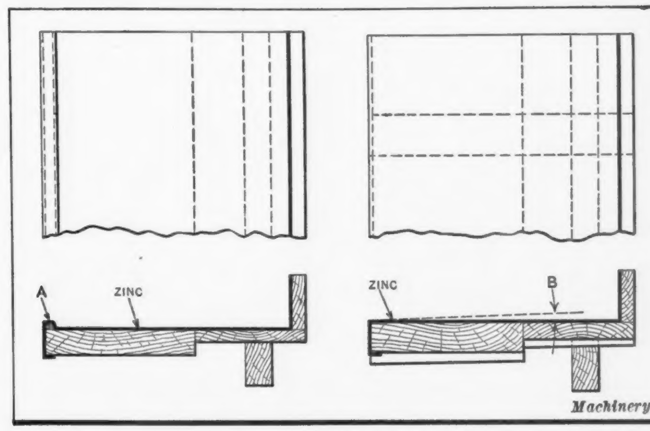


Fig. 14. Two Methods of covering Tops of Benches with Sheet Metal

6-inch stringer which runs the length of the bench. The leg with a flat top shown at *B* may be used with plank of uniform thickness, or by building up, two thicknesses of plank may be used. With this leg, a straight piece *b* bolted to the stringer is used for holding the back-board.

A leg suitable for constructing a double-width bench is shown at *A*, Fig. 8, while the design illustrated at *B* is intended for a single-width bench of the same type. Three forms of bench tops for use with these legs are illustrated in Fig. 9. The upper view *A* shows a cross-plank construction, *B* shows heavy front planks at both sides with thin cross-pieces in the center, while *C* shows the heavy type of construction throughout. In these illustrations it will be noticed that in each case the 2-inch by 6-inch stringer has been run lengthwise of the bench. This adds considerably to the rigidity of the bench and also helps to prevent end sway. With this construction it is not necessary to bolt the legs to the wall.

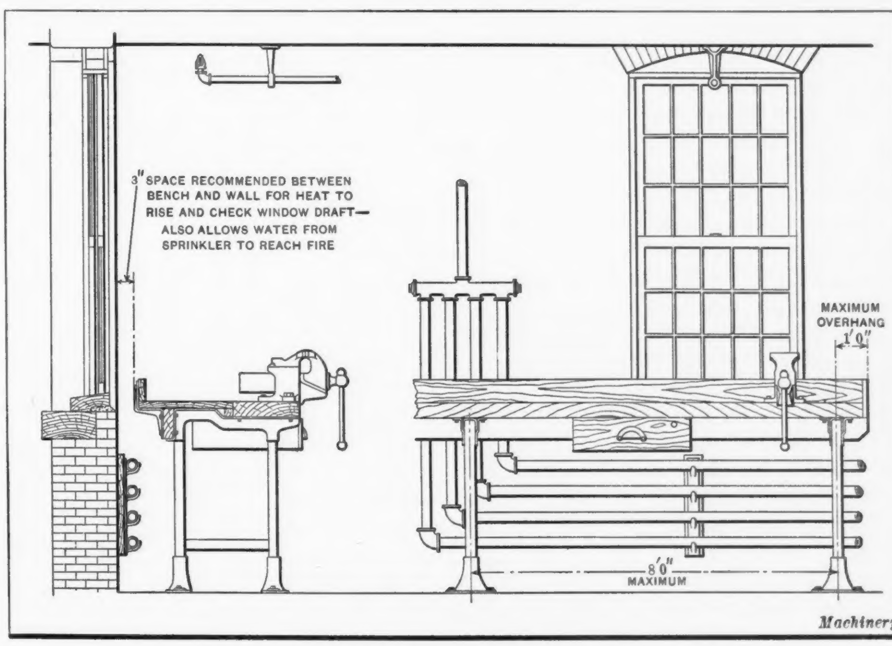


Fig. 15. General Method of arranging a New Britain Work-bench

Two types of bench legs made from cast iron are illustrated in Fig. 10. These views show end sections of both a single- and double-width bench. The construction is obvious from the illustration, the benches being built up from one thickness of planking with one shelf beneath the bench and a back-board. When constructing this bench the back-board *A* should be wedged between the shelf and the lug to provide additional stiffness for the bench, while if a board similar to the back-board is placed between the shelf and the lug *B* a bin is made under the bench. This is sometimes desirable, and also applies to the double-width bench at the right.

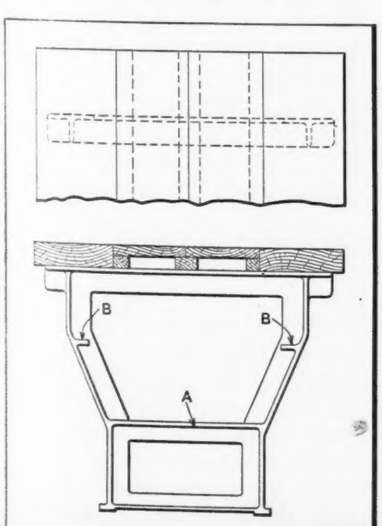


Fig. 16. Double-width Bench with all Planks extending Lengthwise

Three end sections of benches that are set up close to the wall are shown in Fig. 11. The one at *A* is a straight-leg type, while the design shown at *B* has a curved leg. With the straight-leg type, heavy planking is used in front and light boards in the rear. A stringer *a* also is used as a back-board. On top of this stringer a small shelf *b* is provided. The curved bench leg is set against the wall and is built with a cross-piece *c* on top of the leg. A heavy front plank *d* with a light board *e* in the rear are used. The curved shape of this leg enables a man to sit down in the front of the bench with less interference to his knees than in the case of some types of straight legs. The angle-iron type of leg illustrated at *C* must be securely bolted to the wall at *f* and is not very suitable for heavy work. The arrangement of the planking on top of these legs is similar to some of the examples previously shown, and may, of course, be varied to suit conditions.

A construction drawing of the pedestal type of leg is illustrated by Fig. 12. This shows a corner construction and the method of bolting the bench to the wall. The draw-bolt *A* is

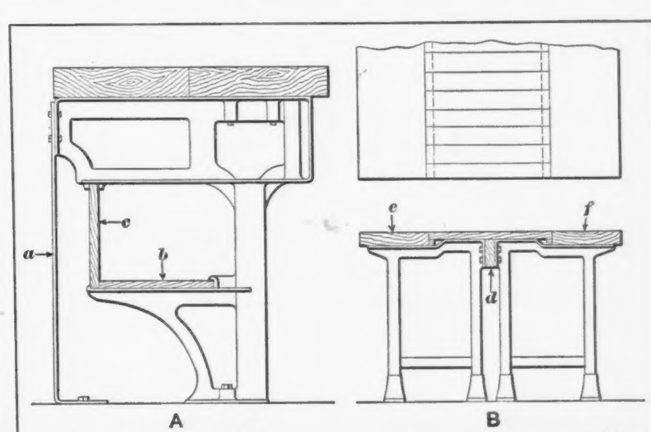


Fig. 17. (A) Method of supporting Pedestal Type of Bench Leg set away from Wall. (B) Two Single-width Bench Legs bolted together

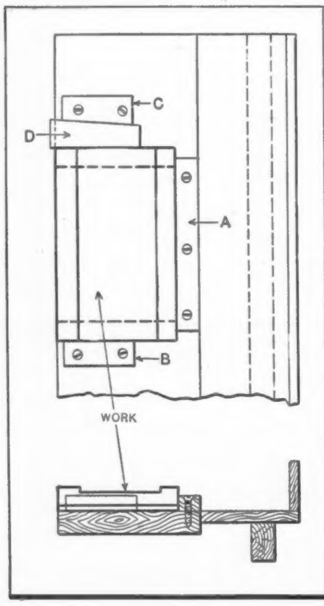


Fig. 18. Simple Method of holding Flat Plates while scraping

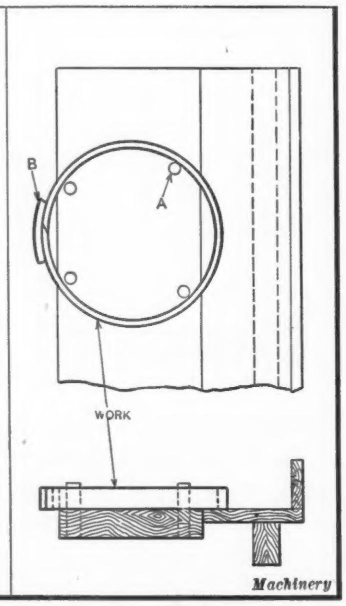


Fig. 19. Use of Pins on Bench for holding Rings

used for holding a vise, thus bringing the vise directly over the bench leg. The gas brackets are placed on a shelf with the supply pipe under it. Another view of a bench showing the corner construction is illustrated in Fig. 13. The arrangement differs from that shown in Fig. 12, as two legs are used at each corner. The construction is obvious from the illustration, which shows both types of corners. This illustration also shows how the planking is laid at the corners to obtain stiffness. Attention is called to the method of rabbeting the corner at *A*. It is sometimes advisable to rabbet the back-plank for its entire length, thus supporting the front edge of the back-plank. This is more desirable where no stringer is provided, as the back-plank is then likely to spring down under heavy loads. The bolts used in bench construction for holding the planks should be placed well to the front of the elongated holes in the legs, so that as the planks shrink the bolts will be drawn back with them, thereby lessening the chance of the planks splitting.

Fig. 15 illustrates some of the features which are recommended in connection with the installation of the New Britain bench. It will be noted that a three-inch space is recommended between the bench and the wall. For ordinary work a distance of eight feet between the legs has been found satisfactory for this type of bench, although for heavy work or where great stiffness is desired, this distance should be less, often being five or six feet. In erecting this bench, it is recommended that the front plank be twelve or fourteen inches wide and three inches thick (planed 2¾ inches). These planks may be obtained in sixteen-foot lengths, which allows the ends of abutting planks to come over every other leg; this eliminates lap joints, which would be necessary were the joints to come between the legs. A convenient method of locating the bench is to set up the two end legs; then by drawing a line tight between these legs all the intermediate legs may be set up to this line.

A double-width bench is illustrated in Fig. 16. With this construction, the planks lie lengthwise and provision is made for hanging shelves on lugs *A* and *B*. When a bench must be set away from the wall, the pedestal type of leg is somewhat at a disadvantage, as it will not stand alone like many of the others which are suitably balanced. This may be remedied by using a brace *a* made of steel as at *A* in Fig. 17. With this addition, this type of bench may be readily erected and is very satisfactory. This illustration shows heavy planking over the entire top, while a shelf *b* and back-board *c* are provided.

Benches of double width with wide legs, while economical when set in the middle of the floor, cannot be taken down and used to good advantage against the wall; therefore, two single-width bench legs, bolted together to form one double-width bench, as shown at *B*, Fig. 17, are sometimes more economical than a double-width leg, when the construction is not likely to be permanent. In this construction, two legs are bolted back to back against a stringer *d*. Heavy planking *e* and *f* is placed at the front of each leg, and narrow pieces laid crosswise complete the construction. These cross-pieces may be hard-wood flooring, tongued and grooved, or plain boards, as desired.

Where a lot of small work is handled on a bench, it is often a good plan to cover the top with sheet metal. In this connection the two views in Fig. 14 are of interest. The view to the left shows a zinc-covered bench top, and it will be noticed that a beading *A* is placed at the front of the bench to prevent the work from rolling off. Another method of constructing a bench top which is covered with zinc is shown by the right-hand view. The bench is tapered back as indicated at *B*. Hard paper is sometimes used for bench covering where delicate work is handled. In some instances, bench tops are built up from small blocks with the end grain on top; these blocks are wedged between stringers and are sometimes glued together, after which they are surfaced with a planer. This

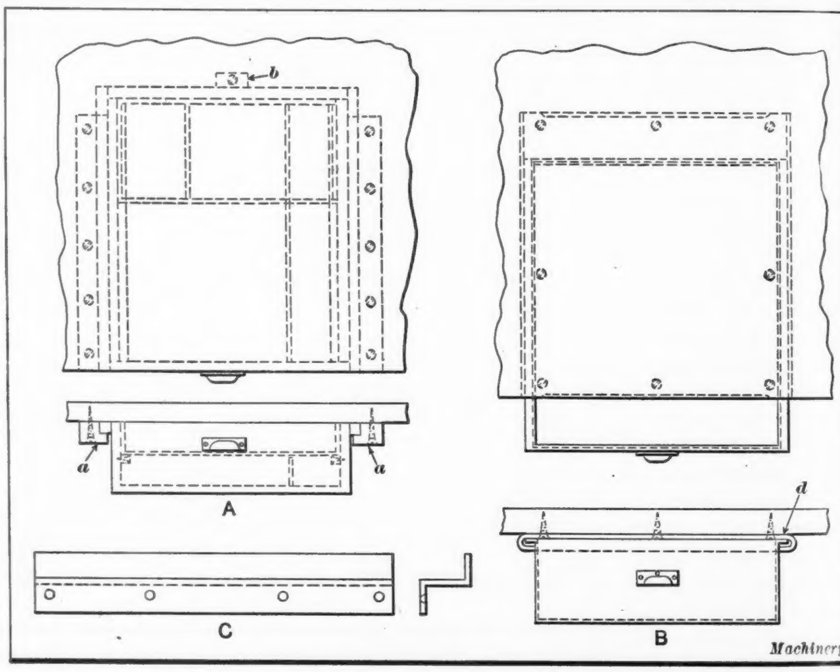


Fig. 21. (A) Wooden Type of Drawer. (B) Sheet-metal Drawer. (C) Steel Drawer Slide for replacing Wooden Strips

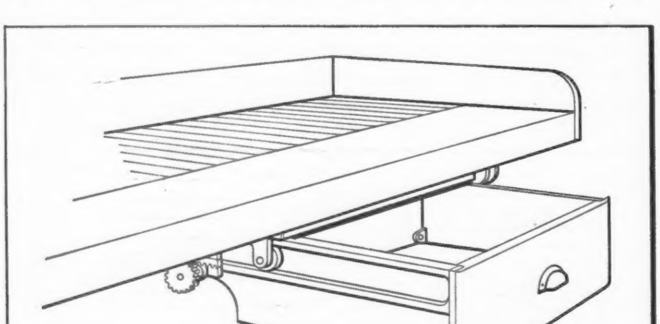


Fig. 20. Bench Drawer supported by Rollers

makes a fine wear-resisting bench and is similar to the wooden paving block constructions often used on streets which have considerable traffic on them.

For handling small castings, etc., it is often found convenient to have a bin under the bench. Fig. 22 shows how this can be arranged without wasting floor space. The bin *A* is placed part way under the bench while the workman stands at the opposite side. A suitable hole is cut through the bin where the bench legs interfere. In fitting up a bench for efficient work, many appliances may be used which will greatly facilitate the handling of work which is to be made in quantities. These often take the form of shelves, stops, holes, etc. To illustrate in a general way what some of these conveniences are, reference is made to Fig. 18, which shows a method of holding work while scraping it. Three blocks *A*, *B* and *C* are attached to the bench and a wedge *D* is used to hold the work securely between these blocks. With this arrangement the scraping may be done much more conveniently than would be the case if some means of holding the work in position were not provided. Fig. 19 shows a method of holding a ring on the bench. Steel pins *A* merely keep the ring in position while screwing the plate *B* in place on the ring.

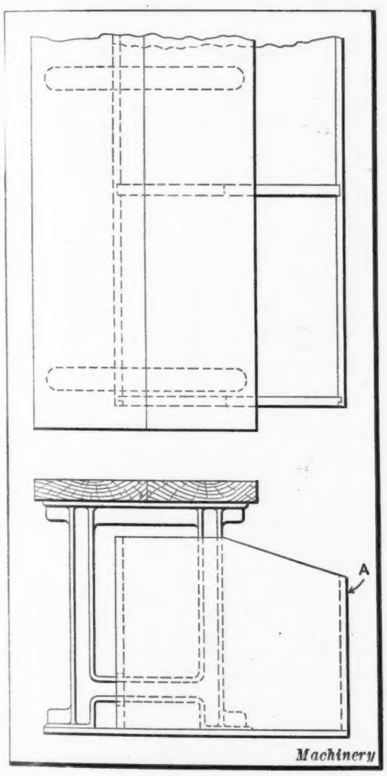


Fig. 22. Work-bench provided with Bin which is located Part Way under Bench to economize in Floor Space

Drawers for Work-benches

The hanging of drawers to the bench is receiving more consideration of late than would be thought by looking at some bench constructions. This refers particularly to the use of metal drawers and covers for them. Referring to Fig. 21, a wooden bench drawer is shown at *A*. This is a common type and is hung on wooden slides. It has a till in it divided into sections for keeping small tools and a block *b* is bolted to the under side of the bench to act as a stop when pushing the drawer in. To prevent the drawer from being accidentally pulled out too far, thus throwing the contents on the floor, a block is sometimes placed under the bench to limit the travel. The view *B* at the right shows a sheet-metal drawer. The drawer proper is hung in the support *d* which is also made of sheet metal and is held by screws to the under side of the bench so that the drawer slides in it. This support acts as a cover for the drawer and assists in keeping out dust. Steel slides, such as are shown at *C* are sometimes used for hanging drawers where something better than wood is desired.

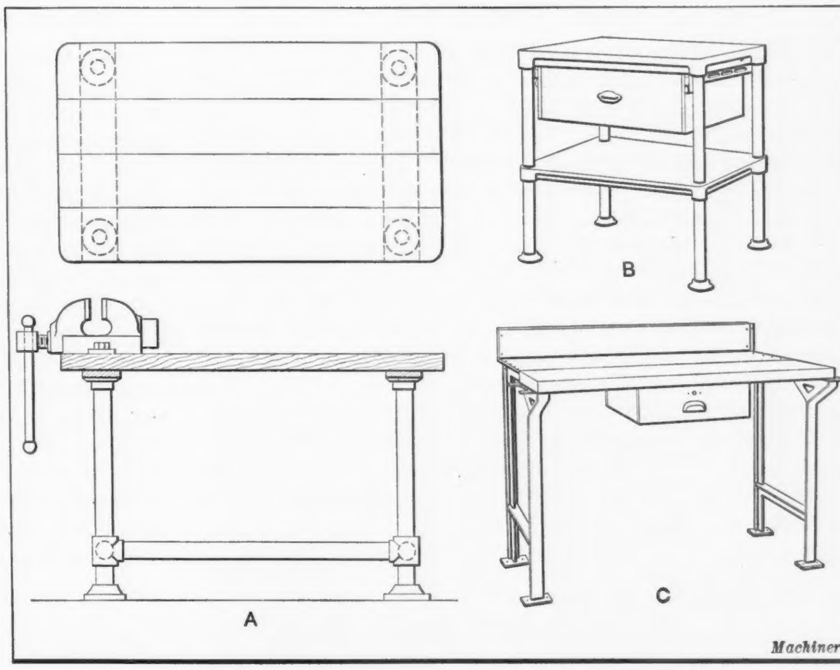


Fig. 23. Examples of Portable Work-bench Construction

A bench drawer hung on rolls is illustrated in Fig. 20. This drawer is made of wood at the bottom, front, and back, while the remainder is of steel; with this construction fine tools are not damaged when thrown carelessly into it. A metal plate is placed over the top of the drawer and is screwed to the bench, thus covering the drawer entirely when closed and preventing dust from entering. The rolls on which the drawer operates prevent sticking or cramping.

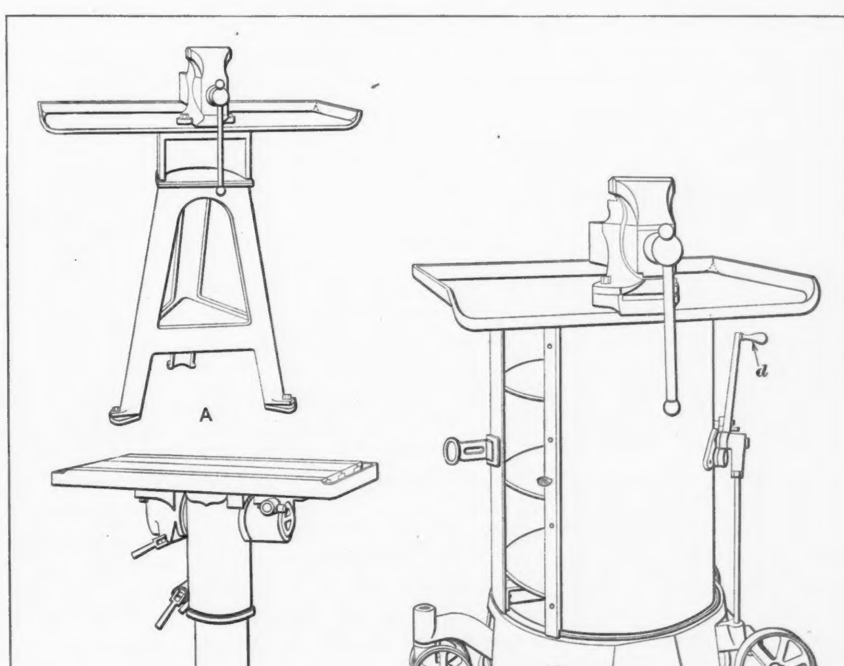


Fig. 24. Portable Stands for Chipping, Filing, and Scraping

Portable Work-benches

Many single-purpose benches that are a complete unit and capable of being moved almost anywhere quite readily are used in many shops and factories. Perhaps the most familiar bench of this type is shown at *A* in Fig. 23. This is used by steam fitters, plumbers, etc., and usually consists of a plank top mounted on four legs made of pipe and stiffened with a cross-piece. Another type of bench carrying a drawer and shelf which is compact and handy is illustrated at *B*. This consists of a wooden top held to a suitable frame and mounted on pipe legs. A work-bench made of sheet metal and constructed in five-foot sections is shown at *C*. Each section is a complete unit which may be used independently or may be bolted to other sections, thus making a long bench. This bench is made by the Manufacturing Equipment & Engineering Co. and is shown with a drawer in position. Where one section is bolted to another, one leg on one of the sections is eliminated. This makes three legs in every ten-foot section throughout the length of the bench.

For filing and chipping on the floor and doing other assembling operations, a bench which is conveniently located and has a vise is greatly appreciated and saves considerable running back and forth. Such a bench is shown at *A* in Fig. 24. This consists of a tray mounted on a three-legged stand. This construction requires no shimming up on the floor as it will take a three-point bearing on an unequal floor. The tray provides for holding a number of small parts, and a vise completes the outfit. Another stand which is used for the same purpose but which is a little more elaborate is illustrated at *C*. This stand is mounted on wheels although when in use it rests on the floor. To move it from one part of the shop to another the wheels are lowered or the stand is raised by means of the lever *d*. This stand is made in cylindrical form with a tray. Inside the cylinder are placed a number of shelves which can be used for holding tools. Another stand which is simple in construction is illustrated at *B*. This stand is for holding work while scraping. It consists of a pedestal and a table which may be tilted to a convenient scraping angle and may also be elevated to suit the workman.

While not all of the benches that are in general use have been illustrated and only a few bench accessories have been shown in connection with this article, it is believed that enough have been described to indicate that the trend of general engineering practice is in the direction of something better than plain wood for work-benches. The bench as an item of shop equipment permits of considerable freak design or construction if one is so inclined, but the writer believes that good benches, properly constructed, mean much more to a shop than is generally supposed.

* * *

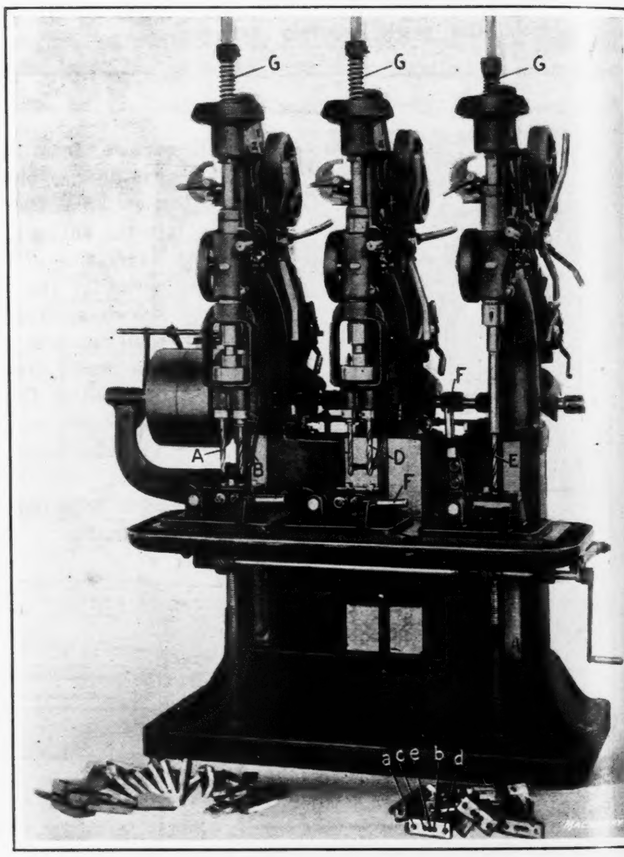
It is stated in *Industritidningen Norden* that the latest German submarines are, in fact, small cruisers of 6500 tons, capable of making thirty knots on the surface and having forty torpedo tubes and twelve guns. The total length is said to be 450 feet, and the width, 36 feet. The engines for driving the boat on the surface develop 20,000 horsepower, and the motors for driving them under water, 5000 horsepower, giving the boats a speed under the surface of fifteen knots. Seventy-six 18-inch torpedoes are carried for each cruise. The submarines also have provisions for mine-laying, and can for this purpose carry 150 mines. Six of the guns are of 5-inch caliber. The vessel is protected by armor plate of from two- to three-inch thickness, and has two telescoping turrets or observation towers. It is stated that these new vessels require about five minutes for entirely submerging.

* * *

Today, the Government is the biggest employer of labor in the United States. Besides the millions in the Army and Navy, it employs over 600,000 civilians, not counting railway employes, and expects soon to increase this number to 700,000. The two next largest employers are the United States Steel Corporation, which has 300,000 men, and the Pennsylvania Railroad, which has 250,000 men.

DRILLING CLOSELY SPACED HOLES

When it is required to drill holes which are so closely spaced that the work cannot be handled at a single operation by a multiple-spindle drilling machine or by a single-spindle machine equipped with a multiple auxiliary head, it is sometimes possible to provide for drilling two or more holes at a time, so that the number of operations required to complete drilling all of the holes in the work is materially reduced. At the left-hand side of the drilling machine shown in the illustration which accompanies this description, there are shown a number of die blanks in which it is required to drill five holes as shown in the finished work at the right-hand side of the machine. To facilitate handling this work, a 20-inch drilling machine built by the Barnes Drill Co., of Rockford, Ill., was equipped with two-spindle multiple heads on two of the spindles, while the third spindle was furnished with a single drill. A quick-acting jig was provided under each spindle. In operation, holes *a* and *b* are drilled by twist drills *A* and *B* carried by the head in the first spindle of the machine, after which the work is transferred to the fixture under the second



Barnes Three-spindle Drilling Machine tooled up for drilling Five Closely Spaced Holes

spindle, where holes *c* and *d* are drilled by drills *C* and *D*. Then by transferring the piece to the third spindle, hole *e* is drilled by drill *E*, thus completing the sequence of operations. All of the fixtures are operated by simply manipulating handlevers *F*, and it will, of course, be understood that the operator goes from fixture to fixture, removing the finished part and substituting a fresh die blank so that each spindle of the machine is kept in practically continuous operation. Attention is called to the fact that coiled springs *G* are provided to furnish automatic return for the spindles of the drilling machine.

E. K. H.

* * *

A committee of the American Society of Civil Engineers has decided that it is unwise to assume a higher working stress than 12,000 pounds per square inch for columns in which the ordinary grade of structural steel is specified. Its report also emphasizes that, as the physical characteristics and strength of structural steel are affected by the amount of working received, heavier material, of the same chemical composition, is weaker.

SOME FACTS ABOUT WASTE

The waste found in machine shops, engine rooms, or wherever machinery is used is generally regarded simply as a mass of cotton threads and fiber not mixed according to any plan, but thrown together promiscuously and just as the material happened to be when discarded by the cotton mill. Much waste of this kind has been and still is used, although waste which has been subjected to manufacturing processes to secure a standardized product is different in both appearance and in effectiveness from the kind of waste first referred to. The former is simply raw material from which waste of good quality may be made. Owing to the universal use of waste, some of the more essential facts regarding different kinds that are in use and methods of producing them will doubtless be of general interest.

There are two principal classes of waste. One class is intended for cleaning purposes and the other for holding a lubricant, as, for example, when used as a packing material in the journal boxes of railway cars or in some classes of motor bearings. The various grades of cotton waste comprise the first class, whereas wool waste comprises the second class, which is used as packing. The cotton or cleaning waste is by far the most important commercially, if judged by the extent of its use. The most essential property of waste is its oil-absorbing quality. Poor waste is soon saturated with oil or grease, whereas good waste will absorb much more oil and may be turned inside out and used again. A high absorbing quality is desirable both in cotton and wool waste, but the importance of this feature might easily be overlooked, especially in the case of waste used exclusively for cleaning purposes.

To obtain a waste capable of absorbing the greatest amount of oil and grease, it is essential, in the first place, to use the right kinds of raw materials and, second, to mix these materials thoroughly and separate the various threads or fibers completely, so that there are no solid masses or large thick strands extending through the waste. At the plant of the Royal Mfg. Co., Rahway, N. J., twelve standard grades of cotton waste are made, in addition to the wool waste made for packing journal boxes. There are about forty different kinds of raw materials used in producing the different grades of waste mentioned. These raw materials vary considerably,

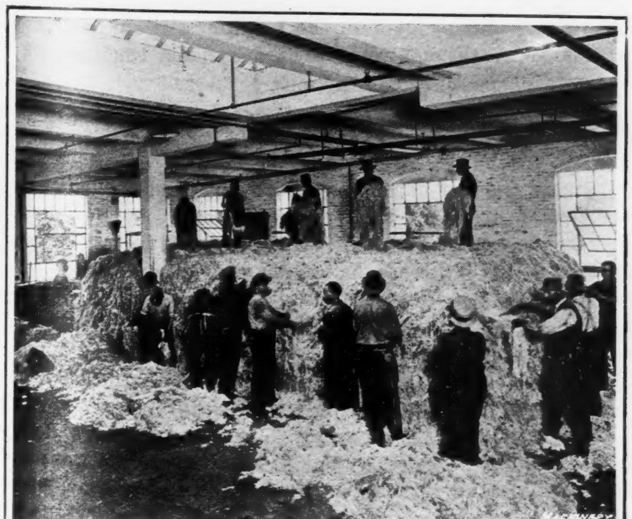


Fig. 1. Method of mixing Ingredients used in Manufacture of Waste to insure Correct Proportions

and the kind of waste obtained depends upon the mixture. The general method of mixing the different materials is indicated by the illustration Fig. 1. To begin with, a bale of waste is spread out over a surface about 15 feet wide and 40 or 50 feet long. Another bale of different material is next spread out in the same way upon the first one, and this is continued until there is a pile of these horizontal layers of mixed waste 5 or 6 feet in height. The particular materials used have been determined previously by experiment and are standardized, so that any one of the different grades referred to is obtained by varying the mixture.

The next step in the process is known as "pulling," and this is shown in Fig. 1. This is another hand operation, and consists in pulling out handfuls of the waste from the sides of the pile. The object is to thoroughly mix the horizontal layers, and in order to do this, the pulling is done by removing vertical layers so that about the same amount of each ingredient is obtained in the mixture that is removed from the pile. This pulled material is next passed through machines, Fig. 2, which completes the mixing and also separates any thick masses or strands so that the waste comes out light or fluffy and evenly divided. This machine has a large cylindrical drum covered with thousands of teeth, and it is partly surrounded

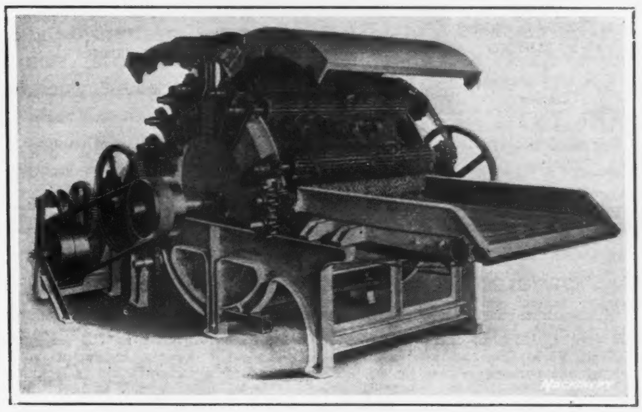


Fig. 2. Type of Machine for combing Waste to secure Homogeneous Mixture

by a series of smaller rollers having intermeshing teeth. As the waste passes between these various rows of teeth, it is torn apart and shredded so that an even, homogeneous mixture is obtained. All waste passes through two of these machines to insure thorough treatment, and the rolls or "laps" which emerge from the second machine represent the finished product, which is put up into bales of different size or weight. In order to remove all extraneous matter, such as splinters, pieces of wire, needles, etc., the raw material is sorted and hand-picked before mixing, and the waste is also screened after mixing and before feeding it to the machines. F. D. J.

* * *

WOMEN IN BRITISH INDUSTRIES

According to the British *Labor Gazette*, about 1,413,000 women, excluding casual agricultural laborers, are directly replacing men in Great Britain, the largest number being in industrial and commercial occupations. The proportion of women to the total numbers of employes increased from under a quarter in July, 1914, to over a third in October, 1917, although it has not appreciably altered since July, 1917. In addition, woman labor equivalent to 43,000 full-time workers is employed in military, naval, and Red Cross hospitals. About 400,000 of these women have been taken from small workshops and domestic service, but there is still a net increase of about 1,070,000 women employed in occupations outside their own homes. It must be borne in mind, also, that much of the work previously done by domestic servants is now done by unpaid labor.

In the industrial occupations the greatest gain is found in the metal trades, in which the number of women employed increased from 170,000 to 549,000. In the clothing trades, on the other hand, the number decreased 44,000, and in the printing trades, 5000. In the chemical trades, there was an increase of 53,000 women employes; in the food trades, an increase of 28,000; and in the wood trades, an increase of 29,000. The statistics of the Ministry of Labor show, however, that the demand for woman labor is now arrested, if not declining. As a result, many of the leading manufacturers and government officials are beginning to plan for the demobilization period.

* * *

According to a bulletin issued by the American Railway Engineering Association of Chicago, on curves of 8 or 9 degrees, the abrasion of manganese rails is only one-fifth that of Bessemer steel rails and one-third that of open-hearth rails.

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THE DANGER FROM WITHIN

Beyond the shadow of a doubt we shall, in time, overcome the enemy outside our gates; the real danger to us is from the enemy within—the German propaganda which works in mysterious ways and never sleeps. Not always does it appear openly as propaganda; sometimes, hiding under apparently patriotic motives, it takes the form of criticism of governmental activities, the ultimate purpose of which is to cause discouragement and apathy. This sort of propaganda is the mother of all the rumors of calamity that beset us daily. It caused the Italian reverse last fall; it is at work in this country just as it was in Italy—in factories, mills, and offices.

The Government can best combat this insidious propaganda by full and frank publicity. Why not tell people exactly how matters stand? German spies in this country probably know already and take advantage of the fact that the rest of us *do not know*. Let the Government give us the facts, good or bad, and thus confound the German propagandists. This is particularly applicable to the machine industries, because most of the discouraging rumors—many, no doubt, emanating from enemy sources—have to do with our delay in manufacturing war material. The Germans have known all along that we were not prepared for war; to say so need not worry us now. But if the people are told also how rapidly we are going ahead with our preparations, much will be done toward counteracting the aid secrecy has given to German propaganda.

* * *

MUST A MACHINE BE RUNNING ALL THE TIME TO PROVE ECONOMICAL?

Manufacturers of specialized labor-saving machinery often find difficulty in selling their machines because, in some shops, the machines cannot be kept busy all the time. Many managers of machine shops, instead of calculating how much work a machine will do when working, seem to worry because a machine may be idle part of the time. They prefer, therefore, to buy a cheaper machine of lower production because it can be kept working continuously. Such a course, as a general rule, is a mistake. Unless a high-production machine costs a great deal more than a low-production machine, it will certainly prove the more economical of the two, because of the labor saved in its operation. And even if the investment on a high-production machine is greater, it is fair to assume that the factory purchasing it will eventually grow and be enabled to utilize the machine all the time. When this point is reached, additional machinery need not be installed and the cost of labor will be reduced—a very important saving of expense. The question is not: "Will this or that machine be idle part of the time?" The question is: "How much does it cost to produce a unit amount of work?" The machine that reduces the unit cost is the cheaper machine, even if it does not run more than half the time.

* * *

STANDARDIZATION—THE KEYNOTE OF EFFICIENCY

Though we have prided ourselves for years on our standardized methods in many lines of manufacture, nevertheless, as a nation, we have only just begun to scratch the surface in so far as economy due to standardization is concerned. Here, as in so many other directions, the war has taught us a lesson. Instead of building locomotives of numerous different designs, varying only slightly from each other in efficiency and adaptability, the large locomotive companies now seek to standardize their types, so that, by reducing the number of designs, they may decrease the cost of manufacture. The same idea is being applied to shipbuilding. There is no reason why many ships of similar tonnage should not be built exactly alike; yet, in the past, nearly every vessel turned out has been different from others.

In the machine tool industry, the possibilities for standardization are by no means exhausted—many firms still build dozens of different types of machines and many sizes of the same type. The manager of a large machine-tool building plant stated that it actually furnished three hundred different machines—that is, machines which differed more or less in their details. Yet many of these different types could perform practically the same work with the same average efficiency. A saving might be made by reducing the number of different kinds of machines if only customers could be brought to appreciate the saving in first cost that would result if they did not insist on so many types and sizes.

Standardization is a big problem, one that will tax many minds before it is solved; yet its underlying principle is easily grasped. The application of this principle, as a means toward economizing both in the manufacture and use of machine tools, is the next step toward national efficiency.

* * *

PATRIOTISM AND PRODUCTION OF MUNITIONS

Winning the war depends as much upon the workers in our factories as upon our soldiers at the front; but few of our workers seem to realize it. "Production could be tremendously accelerated," said the production engineer of one of the largest war munition factories in the United States recently, "if only the fires of enthusiasm could be kindled in our workers; if only they could be made to understand that, to bring the war to a victorious end, they must put the same enthusiasm into their labors as is shown by the men who have gallantly volunteered to serve in the trenches. American workers do not seem to realize as yet that they are fighters in the war; that *production* is the way in which they can most conclusively prove their patriotism. Liberty Bonds are necessary; so are Red Cross contributions, and there is no denying that all classes in the country have bought bonds and contributed to the Red Cross in a fine spirit. But, if each worker increased his production 10 per cent, he would be doing more toward ending the war quickly than he could possibly do in any other way; because, after all, war is fought, not with money, but with materials. No matter how much money liberal subscriptions to the Liberty Loan may bring the Government, little will have been gained unless our producers of munitions and other war materials put their very heart into producing these as rapidly as possible."

"*Production!*" That must be the watchword of every American mechanic, be he engineer or toolmaker, superintendent, foreman, or machine operator.

THE FUTURE STATUS OF THE APPRENTICE

RESULTS OF PRESENT TRAINING METHODS AND SUGGESTIONS FOR AN IMPROVED COURSE

BY C. C. HERMANN[1]

Some time ago the writer's attention was attracted by an article in MACHINERY entitled "Who Blundered—the Draftsman or the Machinist?" Articles on the same topic that followed were also read with interest, but it seems to the writer that the solution of the problem lies much deeper than appears from perusal of these articles. In the first place, the machinist, toolmaker, or patternmaker must, under present conditions, serve an apprenticeship of four years before he can call himself a member of the craft. During the first year of apprenticeship a boy must often do odd jobs about the shop—sweep the floors, wipe machines, etc. In the second year he is allowed to run a drilling machine, set up work in the lathe, and do some bench work. In the third year he does bench, vise, and floor work, is taught how to make precision measurements, and has a chance to become acquainted with milling machines, setting up automatics and checking set-ups. His fourth year is practically a review of the first three years—the finishing touch upon his apprenticeship. During those four years he sees blueprints of various parts and gets some instruction in reading drawings. Yet, despite all this, he finds himself at the end of that time with the essentials of his education still lacking. He has no firm foundation upon which to build.

Machinists should have a well-grounded knowledge of drawing—a fact which employers have ignored to their sorrow. The writer is personally acquainted with men holding positions as foremen and superintendents of machine shops who are unable to make a mechanical drawing. They left school early and served apprenticeships in various shops, where they became expert in the work done in the shop, but they have not acquired the foundation upon which to expand. The reverse is true in other cases. Many times men of splendid education have failed in responsible positions because of a lack of practical knowledge. A happy medium must be sought—a middle point between the professions of machinist and draftsman.

For the past two years, the writer has taught a night school for shop men, the total enrollment of which in the mechanical drawing class, for the two years, was thirty-two. All those enrolled were practical men, ranging in age from twenty-two to forty-four years. Eight were laborers, seventeen were machinists, five were apprentice machinists, and two were toolmakers. Two had spent two years in high school, twenty-two had finished their eighth grade studies, three had finished the fifth grade, two had finished the fourth grade, and two had never been to school. The two students who had spent two years in high school were apprentice machinists and excelled the rest of the class in every way. Moreover, they were far in advance of the average apprentice in their work, and, but for the ruling regarding ages, would have finished their apprenticeship in two and a half or three years. For the rest of the class, plain mathematics was the stumbling block; fractions, especially, seemed to dumbfound them. To add and subtract fractions was as complex to them as problems in combined torsion and bending stresses are to the average designer. Yet some of these men, who had been machinists ten years and more and had studied fractions in the grade schools, had forgotten all about them!

The men of this class seemed to measure up to about the average of men working in shops, so that what was learned regarding them may be taken as typical of their class. It appears, then, that about 4 per cent of our machinists, toolmakers, and patternmakers have had part of a high school education, 70 per cent leave school without going on to high school, 4 per cent have never been inside of a school, and 22 per cent have had about four years of schooling. In view of this, an employer should consider it lucky that more mistakes do not occur in his shop. Much can be done to improve these conditions. That the evening classes held by the Y. M. C. A. throughout the country are a real asset to employers can be proved by these typical instances: One Y. M. C. A. pupil, who had been a machinist for two years, is now foreman in a shell-producing plant; another is foreman in a railroad machine shop; six others have done such good work that they are in line for advancement.

An Improved Apprenticeship Course

The writer believes that the following program for the apprentice will eliminate many of the shortcomings which handicap machinists who have served their apprenticeship under present conditions: The first year should be spent by the apprentice alternately, in three-month periods, in the tool-designing department and the machine shop. In the tool-designing department he should do tracing the first three months and learn how to handle drafting tools and the meaning of the various lines, as well as how to read a working drawing. The second three months should be spent in the drafting-room in actually making drawings, simple parts to begin with, the more complex assembly drawings to be reserved for the latter part of the term.

In the machine shop, the apprentice should not be placed at once on a machine, but at the bench, where he should be taught how to handle the various hammers, such as the ball and peen—both the straight-peen and the cross-peen—and how to use center-punches, chisels, and files. The shop foreman should lay out the apprentice's work at first. In addition, the apprentice should be taught how to sharpen his tools, after which he should be expected to keep them in good order and in logical arrangement in the drawers and on the shelves. He should be taught the use of scribers, surface gages, calipers, and the various methods of laying out tools. His work should be at first such as admits of wide variations; work to the finer allowances should be reserved till later. The employer should bear in mind that the value of his apprentice will depend on how he is started at the work; a bad start can bring only failure. Some maintain that the shop is not a school. They are in error. The shop is the best schoolhouse on earth; it is the school of experience. What a man learns at his bench he never forgets, and it is for this reason that the apprentice should be placed under the best mechanic in the shop.

If some system of reading working drawings were practiced in the machine shop, it would lessen the chance of error, and the machinist would be able to make himself more familiar with the work in hand. The fact that educated workmen are essential has been recognized by some of the leading manufacturers in the country; some even go so far as to pay for the tuition and buy books for any of their employes who wish to study at night. The writer was informed by a chaplain of the Regular Army not long ago that, of the men in his regiment, 191 could not write their own names—and these 191 were of American parentage. Before enlisting, these men had been working at various trades. Many of them were desirous to get an education and were delighted to enroll in the classes formed by the chaplain, where they are now learning to read and write English. Right now is the time for the manufacturer to give serious consideration to this phase of his business. Educated men mean greater efficiency, and greater efficiency is necessary at a time when there is a limited number of workers available.

* * *

The locomotive and railroad car builders of the United States did a gross business in 1917 of $575,000,000, an increase of approximately $55,000,000 over the preceding year. The number of locomotives ordered, up to December 31, was 5585, compared with 5016 the year before. Of these, 3413 were for the United States and her allies, with a small number for neutral countries and the remainder for domestic railroads. But only 125,330 freight cars were ordered, against 190,663 the year before. Foreign orders, including cars for the railroads in France operated by the American Army, totalled 66,667, while the home railroads ordered only 58,553. Only 558 passenger cars were ordered, as compared with 1854 in 1916 and 1839 in 1915.

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Forging the U.S. 75-Millimeter Shell

Fourth of a Series of Articles Describing Approved Methods Employed in the Forging and Machining of the U. S. 75-millimeter Shell — By Erik Oberg[1]

THE machining and the inspection of the U. S. 75-millimeter high-explosive shell have been described in a series of articles in the March, April, and May numbers of MACHINERY, the practice dealt with being that of the American Shell Co., Paterson, N. J. In the present article, the methods and tools used in the forging of this shell will be described. The forgings for the shells made by the American Shell Co. are furnished by the Hydraulic Pressed Steel Co., Cleveland, Ohio, and the practice of the latter company will, therefore, be described. The plant of the Hydraulic Pressed Steel Co. has a capacity for forging 20,000 shells daily, and is now being increased so that the ultimate capacity will be about 65,000 shells per day.

Nicking and Breaking

The steel from which the forgings are made comes from the steel plants in long bars, 82 millimeters (about 3¼ inches) in diameter and 10 feet long. The length of the bars varies slightly. The steel is open-hearth, Class B steel for common shells. This classification refers to that adopted by the United States Ordnance Department, in the revised specifications of December 31, 1917. The maximum phosphorus and sulphur content of Class B open-hearth steel, when made by the basic open-hearth process, must not exceed 0.06 per cent. The steel bars when received are marked on the end with a "heat number" stamped on them at the steel mill. This heat number is retained through all the operations and is stamped on the forgings before they are sent to the shops where the machining is done. When the bars arrive from the steel plant, they are stored in stock piles in the yards until the total number of bars in a complete heat have been received. A complete heat usually contains from 350 to 400 bars.

When ready to be used, the bars are taken from the stock pile in the yards and rolled into the shop on a conveyor provided with plain grooved rollers. The first operation is to break up the bars into units about 9 inches long, which are known as "billets," from which shells are afterward forged. The breaking up is done by first nicking the bar by means of an oxy-acetylene torch, and then breaking it off under an alligator shear. While nicking the bars by the torch, the operator of the torch is guided by a gage frame which has cross-bars 9 inches apart, so that, as the bar is pushed beneath the gage frame, it can be nicked at the exact points where it should be broken off, to provide proper lengths for the shell-forging blanks. After nicking, the bar is passed to the alligator shear, which breaks it up into pieces. It should be understood that there is no cutting action, but purely a breaking action.

After the bars have been broken as described, the billets are inspected for structural and surface defects by rolling them down a slight incline, the inspector observing the cylindrical surface as well as the end of the billet as it rolls along. The billets from one heat are all kept together and are stacked in piles, which are not used until the entire heat has been broken up. The piles are identified by the same marking as the bars. When the complete heat has been broken up, the billets are ready for the forging operations.

Forging the Shell

The billets are carried from the piles to the furnaces in large steel boxes by an overhead crane, and are then placed in the heating furnaces preparatory to forging. These furnaces are oil-fired.

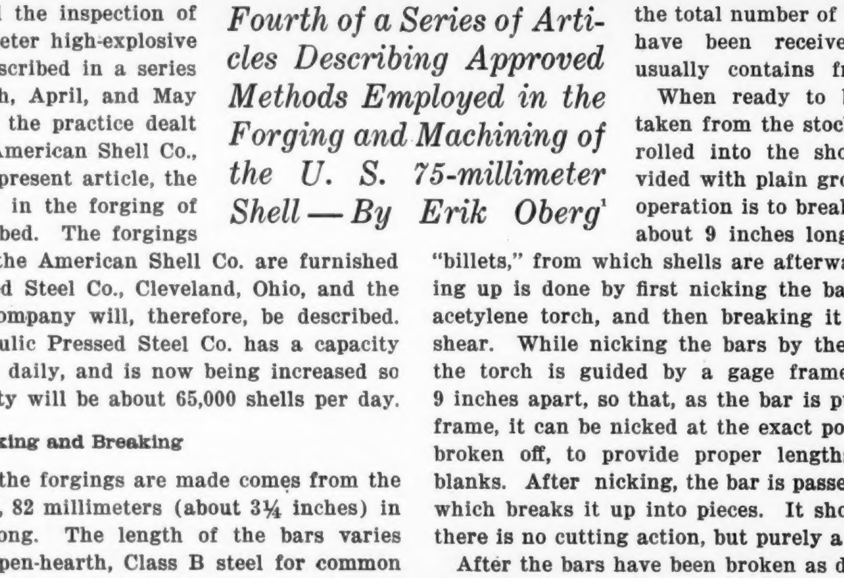

Fig. 1. Alligator Shear used for breaking off Billets from Bars

[1] Editor of MACHINERY.

The temperature in the furnace is maintained at from 2200 to 2400 degrees F., and the billets are heated to a temperature of from 1800 to 2200 degrees F. The billets remain in the furnace for forty-five minutes in order to be thoroughly "soaked" through. Sixty billets can be heated at once in one furnace, and four furnaces are used to each one of the hydraulic forging presses which perform the first forging operation. The press for the first forging operation, which is of the hydraulic type built by the Southwark Foundry & Machine Co., Philadelphia, Pa., has an average capacity for forging 220 shells per hour. After the first forging operation, the shells are immediately taken to the second-operation forging press without being heated again between the operations. There are two first-operation presses to each one of the second-operation presses. The presses are arranged so that one first-operation press is located on each side of a second-operation press, there being three presses to one unit. In this way, the shells can be readily passed from either one of the two first-operation presses to the second-operation press between them.

The first-operation press is provided with only one die and plunger, but the second-operation press has four dies and plungers, although only two are operated at a time, each set of two plungers being operated alternately, so that the other set has a chance to cool off. In the first-operation presses, the plunger and die are cooled by circulating water inside of the tools, but in the second-operation press, the plungers are immersed in a deep cup filled with water between each active stroke, and the water overflowing from the cup when the plunger is immersed in it runs over the die and cools it also. In the second-operation presses, the partly forged shells are subjected to two separate forging operations; the first makes the bottom of the correct thickness, and the second draws the walls to the right length.

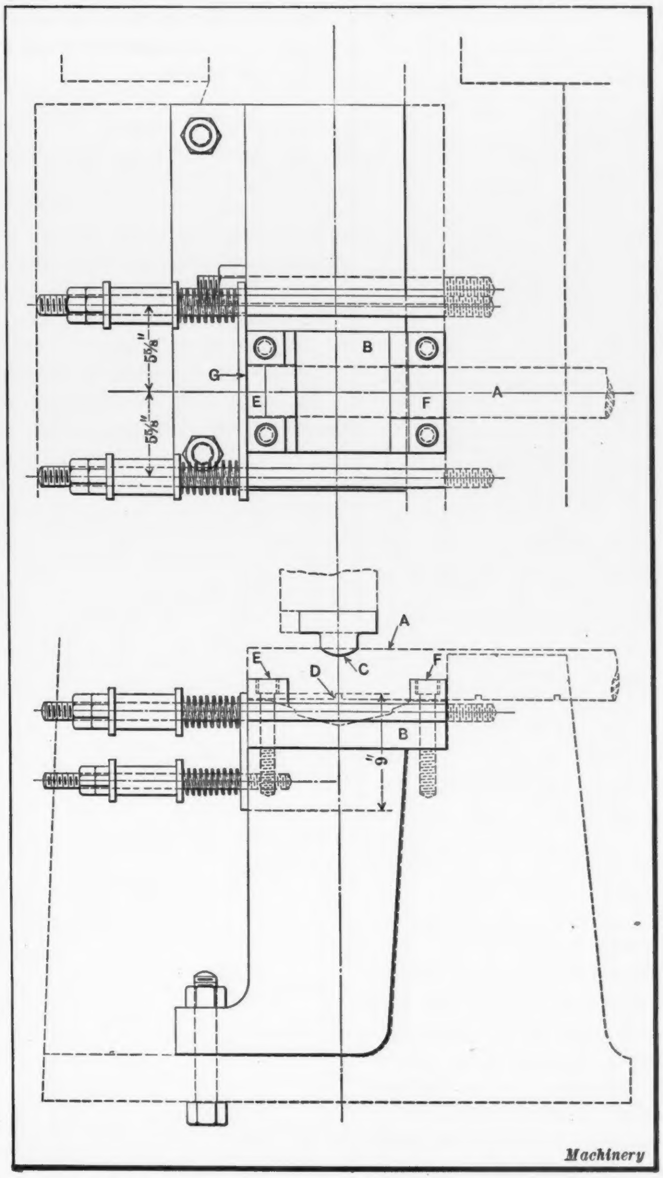

Fig. 2. Tools for breaking off Billets from Nicked Bars

Testing and Inspection

After the forging is completed, the shells are inspected while hot by an inspector who measures the length and the thickness of the bottom and tests the concentricity. The forgings are then piled on a truck especially designed for carrying them to the cooling bed. This truck consists of a plate bent up at the ends to a semicircular form, so that the shells, when piled in it, cannot roll off. These trucks are moved by a small electric locomotive to the cooling bed, where the forgings are placed on top of cinders to cool off slowly. When the shells are cold, they are again inspected for length and thickness of bottom and concentricity. At this time the inspector also notes any flaws in the forgings, and inspects the inside finish. The gages used for this work will be dealt with later.

Test pieces are cut from two shells in every heat, in order that tensile tests may be made. As one heat consists of from 3600 to 4000 shells, this means that one shell in every 1800 or 2000 is tested for tensile strength. In order that the shells may pass, the test piece must have an ultimate tensile strength of 90,000 pounds per square inch, an elastic limit of 45,000 pounds, and an elongation of 12 per cent in two inches.

The preceding paragraphs review briefly the complete processes to which the shell is subjected in forging. In the following, the details of the various operations will be dealt with, and descriptions and illustrations of the most important tools, dies, and gages will be given.

The Nicking Operation

When the bars pass into the shop from the yard for nicking, one end comes up against a stop-plate which is used in connection with the gage frame for the oxy-acetylene torches. In this way, all nicks will be uniformly gaged from one end of the bar. The gaging device is hinged, so that, when the bar has been placed in position, the gage can be brought down over it. It consists briefly of a rod long enough to accommodate the longest length of bar to be nicked, the rod having welded to it, at intervals corresponding to the unit lengths to be cut, short arms which act as guides and gages for the cutting torches. The rod is supported in bearings at each end, and when in use is rotated in these bearings, so that the short transverse arms rest on the bar to be nicked. Four torch operators are employed for a ten-foot bar, and as there are about twelve nicks or cuts to be made in a bar of this length, each operator nicks the bar on an average at three places.

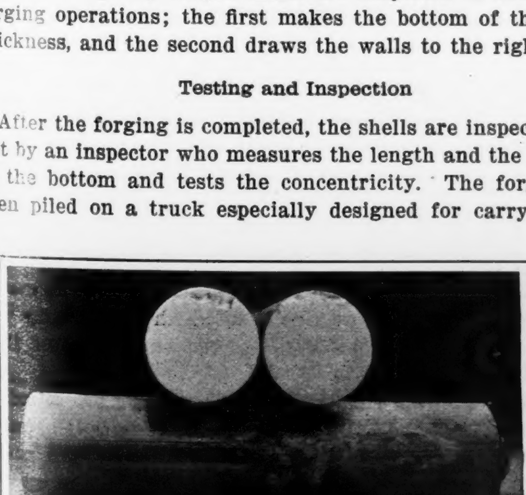

Fig. 3. View showing End of Billets broken off in Alligator Shear, indicating Character of Clean, Smooth Break

Fig. 4. Side View of Billet shown to Left in Fig. 3, showing comparatively Even Break

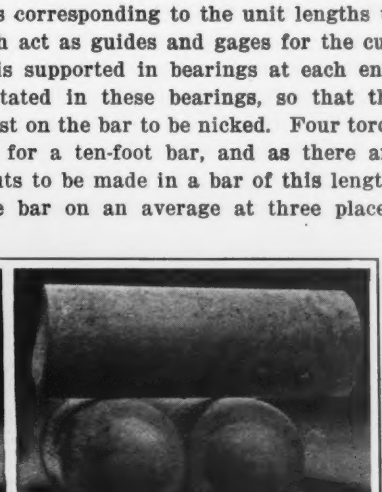

Fig. 5. Side View of Billet shown to Right in Fig. 3, showing Appearance of Break

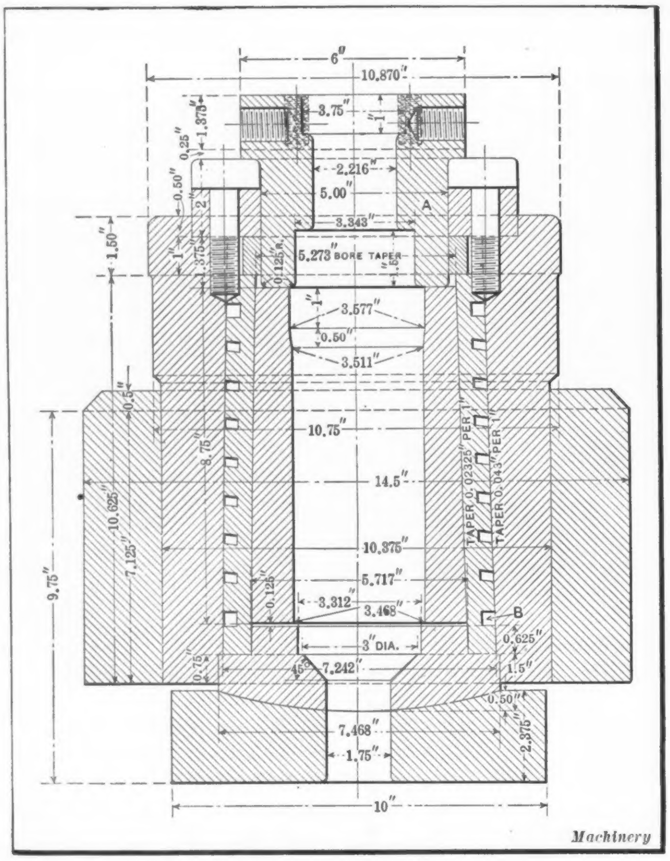

Fig. 6. Details of Die used for First Forging Operation

As soon as the nick is made with the torch, the nick or cut is chilled with a stream of water from a hose suspended from above the nicking table. For the nicking, a Davis-Bournonville Style C, No. 149, tip No. 4, torch is used. While only four torches are employed simultaneously, it would be possible, if the operation had to be speeded up, to use a greater number.

The acetylene for the torches is generated in a 200-pound carbide generator placed in a different part of the building, from which the gas is conveyed by piping to the nicking table. The oxygen is obtained from standard "Prest-O-Lite" cylinders, ten of which are connected through regulating valves to a header in the generator house, and from this header the gas is piped to the cutting table and distributed to the torches through a manifold. The water for chilling the nicks is carried by an overhead pipe and distributed to each torch operator by an individual flexible hose. All the piping is carried over the heads of the operators so as to be out of the way as far as possible.

The bars are nicked on one side only, to a depth of from 1/8 to 1/4 inch, the nick being in a plane normal to the axis of the bar. After the bar has been nicked over its whole length at given distances apart, the gage is rotated out of the way

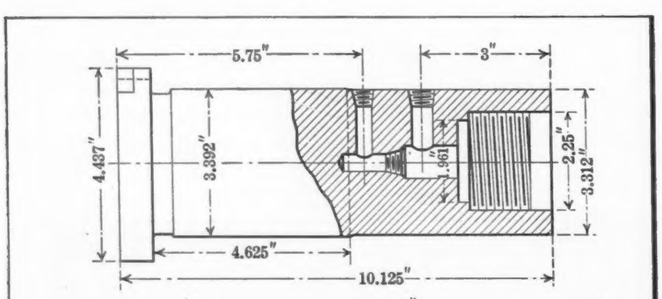

Fig. 7. Punch used in First Forging Operation

and the bar is rolled off the table onto a skid, from which it passes to the alligator shear which is used for breaking up the bar into billets.

The Breaking Tools

A detail of the tool equipment for the alligator shear for breaking off the nicked bar into billets is shown in Fig. 2, where the bar is indicated at *A*, the die, or lower part of the breaking tool, at *B*, and the punch, or upper part of the breaking tool, at *C*. As indicated, the nick in the bar at *D* comes directly underneath punch *C*, so that when the punch is brought down upon the bar, the latter is broken off by the pressure of the punch, the bar resting at *E* and *F* on supports in the die. A stop is provided so that when the end of the bar is pushed up against it, the bar will always be in a position where a nick will come directly beneath the punch. The

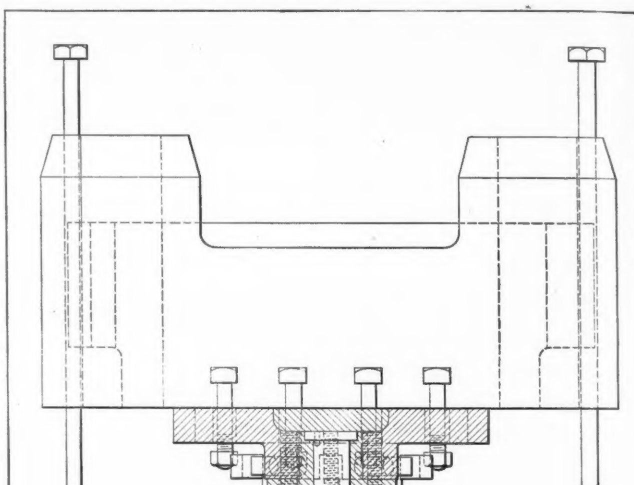

Fig. 8. Assembly View of Punch and Die used for First Forging Operation

plan view of the die shows the bar in place pushed up against the stop at *G*. Springs are provided bearing against the stop-plate so that there is a slight give to it, which is necessary on account of the motion imparted to the broken off part of the bar when the punch descends.

The die consists of a hardened block with two projections, which is fastened to the built-up base of the shear. It should be noted that, when the bar rests in these blocks, the nick should always be downward. It is evident that as the upper block or punch *C* comes downward it tends to bend the part of the bar between the two lower blocks, but, as the material is fairly brittle, and also as the nick on the lower side has already started a break, the bar breaks off with fairly even

ends. An illustration of the alligator shear and the conveyor in which the bar passes to it is shown in Fig. 1.

Theory of Setting the Blocks

A point relating to the breaking off of the bars into billets, which was discovered by experiments, should be mentioned at this time. If a bar consisting of only two unit lengths were placed nick down on *E* and *F*, Fig. 2, so that the nick registered with a plane normal to the axis of the bar and was located centrally between *E* and *F*, and if *C* were set to strike the bar on the top directly over the nick, then the bending moments about *C* would be equal and opposite. Assuming that there are no serious internal strains or lack of uniformity in the material of the bar, the break would be square and even from the nick to the side of the bar which is in contact with *C*. Now, however, except when the last two pieces of a bar are broken apart, one end of the bar extends beyond block *F*, and the weight of this end may be as much as 250 pounds. This additional weight causes an unbalancing of the forces at the

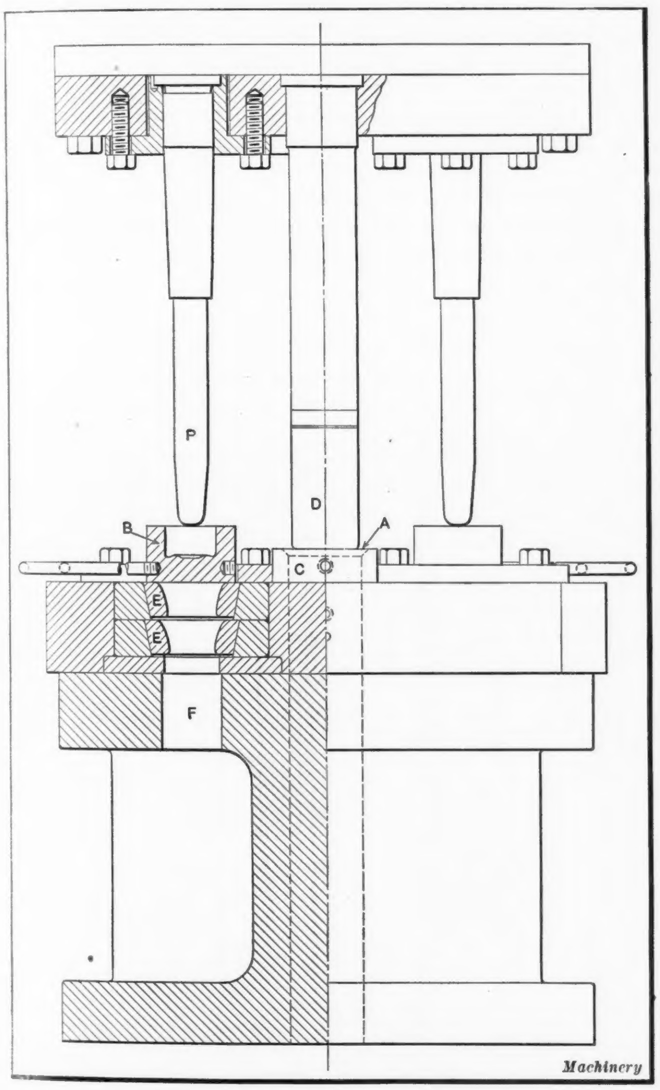

Fig. 9. General Arrangement of Punches and Dies for Second Forging Operation

breaking point, so that the fracture is not straight, but slightly offset toward the side of the smaller piece which is broken off. By experiment, it was found that, by shifting the blocks *E* and *F* in the direction of the overhang, but maintaining the original distance between them, it was possible to determine, by trial, a point for each heat of steel where the breaks would be square across the end of the bar. As it was difficult to make this adjustment in the lower die, provision was made for this instead in the upper block or punch, which can be moved crosswise in the face of the upper jaw of the alligator shear.

This method of cutting off the bars has been found advantageous from many points of view. It is rapid in operation and very simple, and the capacity of a plant may be easily increased, due to the simple means required for the operation.

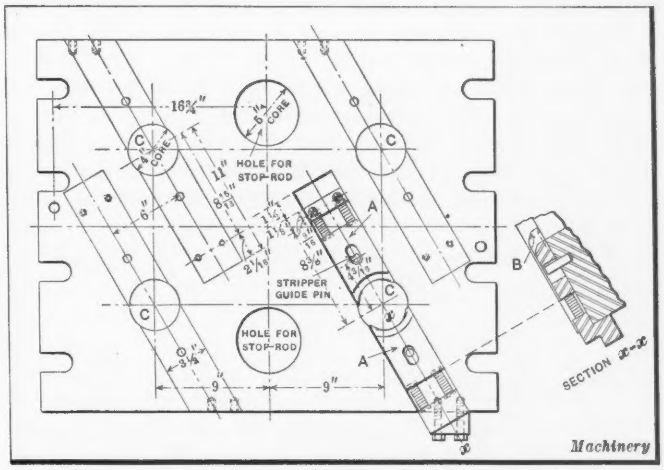

Fig. 10. Plan View showing Arrangement of Strippers for Second Forging Operation

Fig. 3 shows the ends of two billets after they have been broken apart, indicating the smoothness of the fracture beneath the nick. Figs. 4 and 5 show the sidewise appearance of the broken-off billets, indicating the fairly square surface at the break.

Tools for First Forging Operation

Fig. 8 shows a section of the complete assembly of the plunger and die for the first forging operation. The billet, as mentioned, is about 9 inches long, but the cup produced in this operation is about 12 inches long, the metal having been extruded past the punch, to some extent. A detail view of the die is shown in Fig. 6, where the stripper is indicated at *A*. The cooling water passes around the die in the spiral groove *B*, Fig. 8; it enters at the top of the spiral and passes out at the bottom, into the space between the die and the hood, and then flows out through a hole in the hood. The water is taken directly from the city mains and is not circulated, but permitted to flow off through the sewer. The pressure of the water is the regular city pressure.

The pilot at the top of Fig. 6 is entirely hand operated. At the beginning of the stroke the heated billet is put into the die, which is enough larger in diameter than the billet to permit it to enter the hole in the die. The plunger is in its upper position and the pilot is moved out of the way. When the billet is in the die, the operator lifts up the pilot, puts it on top of the billet, and operates the press, so that the plunger passes down through the hole in the pilot and into the billet.

The most important thing to be accomplished in piercing the billet is to provide a hole concentric with the outside of the cup. An attachment called a "spring yoke," shown in detail in Fig. 12, assists materially in accomplishing this result. One spring yoke is passed over each end of the stripper bar *F*, Fig. 8, but is not shown in this illustration; it is located just inside of the rods *G* and held in place by pins passed through the stripper bar; the bar passes through hole *A*, Fig. 12, in the spring yoke *B*. These spring yokes are so arranged that when the spring tension is properly adjusted by means

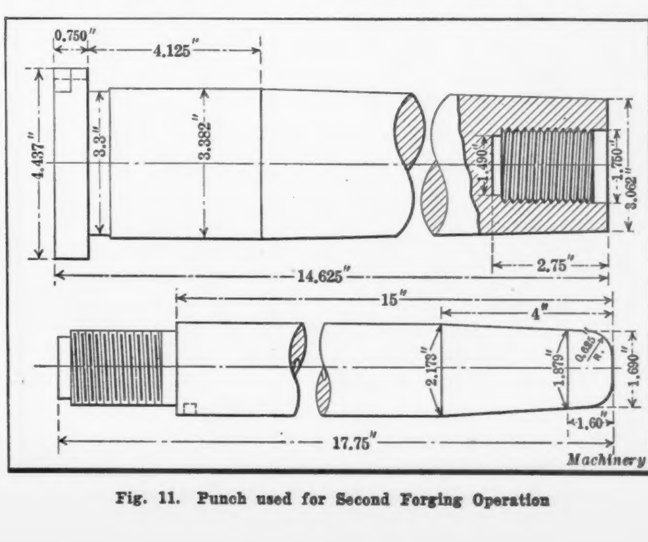

Fig. 11. Punch used for Second Forging Operation

of the nuts C, and the ram of the press is up with the billet in the die, and with the pilot in position, the billet is held up from the bottom of the die by pin E, Fig. 8, so that it extends above the top of the die into the recess provided for it in the pilot. When the plunger comes down, it enters the billet while the latter is still held centered in the pilot, and in this way the hole is started almost perfectly in the center at the top. As the plunger comes down, it forces the billet down into the bottom of the die, pushing the pin E down ahead of it against the spring tension, until the head of

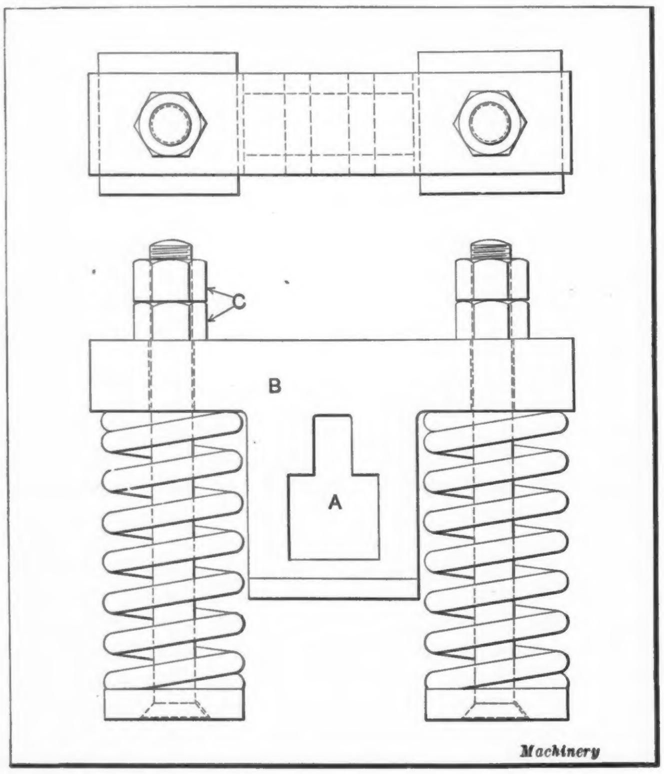

Fig. 12. Spring Yoke for obtaining Concentricity in Piercing

the pin seats in the recess provided for it in the bottom of the die. From this point on, the process is just the same as if a solid die were used.

Another feature of this tool which allows of considerable accuracy in piercing the hole in the cup concentric with the outside is the alignment which is made possible by shifting the bottom of the die, if required, by means of three radial set-screws at C, Fig. 8, which extend through the hood that holds the die in place. These set-screws are set 120 degrees apart. By adjusting the die in the direction of the side of the cup that comes thin, while the top of the die is held in its original position, the alignment can be made nearly perfect.

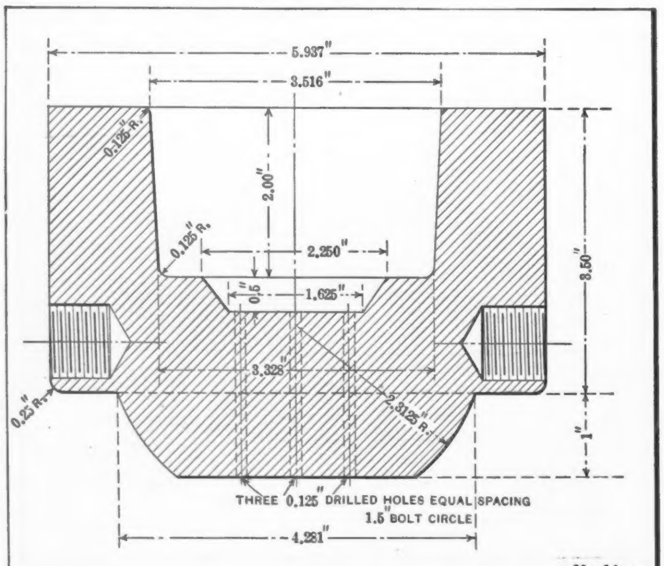

Fig. 13. Die used in Second Forging Operation

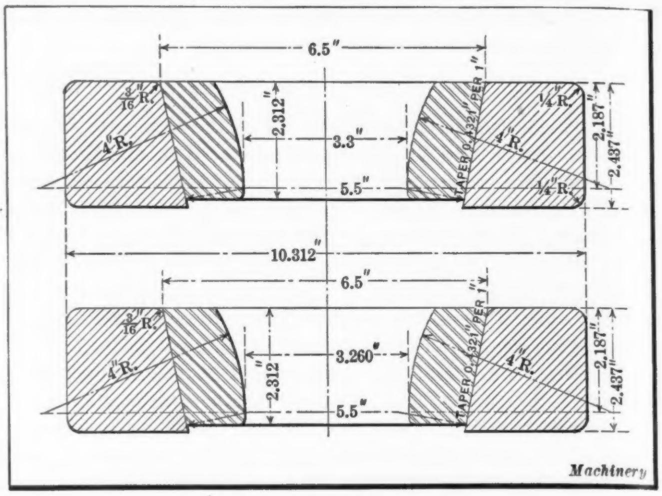

Fig. 14. Dies used for Final Drawing Operation

The valve operating the plunger is controlled by a handle. As the plunger recedes, the pilot and shell are carried up with it until the stripper strikes the stripper jaws D, Fig. 8, thus loosening the shell from the plunger. At this time, the shell is gripped by tongs and transferred to the second-operation press. If the shell should stick in the die, the knock-out E, actuated through a cross-bar F and tie-rods G, as indicated, will operate, and will force the shell out of the die.

The plunger, as well as the die, is water-cooled. In the case of the plunger, Fig. 7, a 1/8-inch gas pipe is inserted in

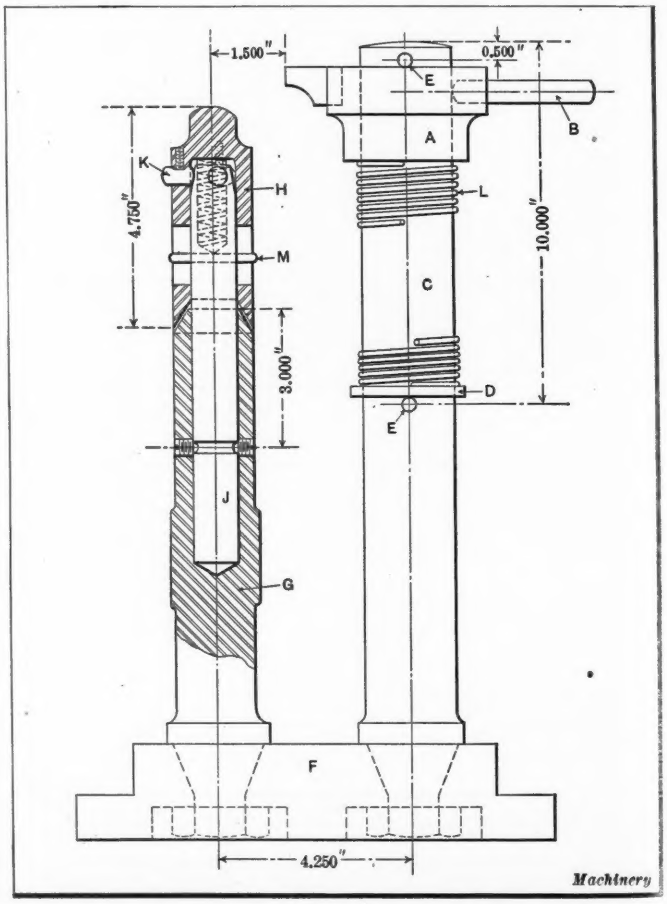

Fig. 15. Gage used for testing Concentricity of Shell Forging

the 3/4-inch hole shown. This gas pipe reaches to within 1/2 inch of the bottom of the hole. Water is forced in through the gas pipe and then passes out of the plunger on the outside of the gas pipe, thus cooling it effectively. Suitable stops are provided for the ram to which the plunger is attached, so that it cannot enter the shell forging to more than a predetermined depth, assuring the proper thickness of the bottom of the shell.

Tools for Second Forging Operation

The second forging operation, as already mentioned, is divided into two parts. In the first part, the cup from the

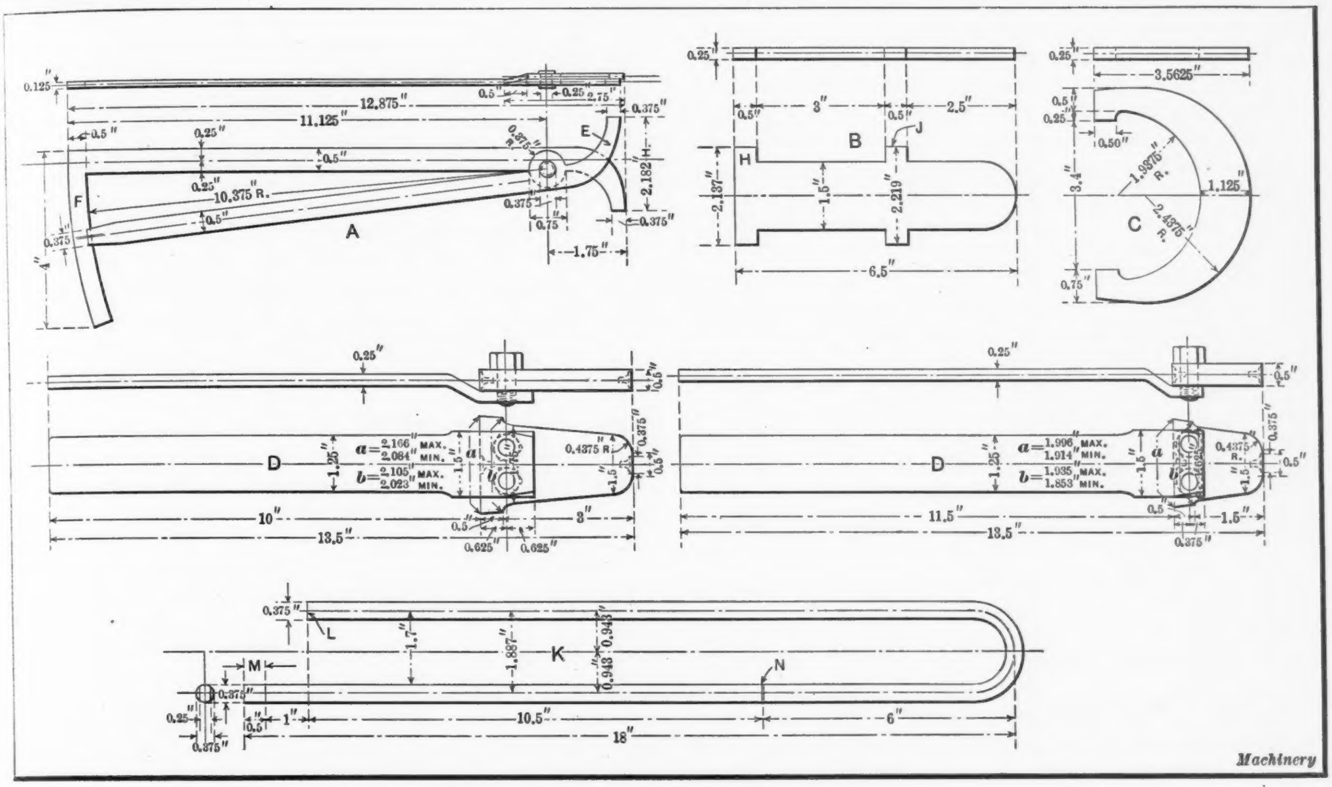

Fig. 16. Gages used for Inspection of Forgings

first operation is placed in die *B*, Fig. 9, and plunger *P* is brought down, providing for the proper inside shape and the proper thickness at the bottom of the shell. A stop-block at *A* determines the depth to which plunger *P* enters into the die, and hence insures the proper thickness of the shell base. As indicated, there are two plungers acting at once. The other two plungers, arranged along a plane parallel to those shown, but about eighteen inches behind them, are not in use at this time, but will be used for the next set of two shells. They are given an opportunity to cool off while the other two are in use. The reason why the plungers in the second-operation press are not water-cooled is that, on account of their small size, the drilling of a hole inside of them would weaken them too much.

The second part of the second forging operation consists in forcing the whole shell through the dies *E*. In order to do this, the plunger, after the first part of the operation is completed, is pulled back with the shell sticking to it; die *B*, to which a handle is attached, is then removed, and slide *C*, which constituted the stop for the plunger *D*, is pulled lengthwise until a hole in the slide coincides with the plunger *D*, so that this plunger does not prevent the ram with the punches at-

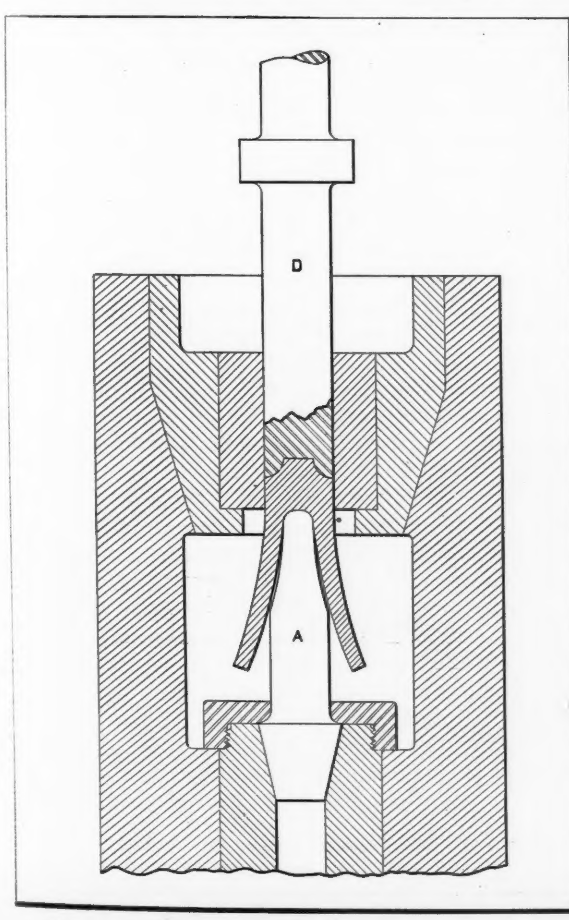

Fig. 17. First or Piercing Operation in French Method of forging Shells

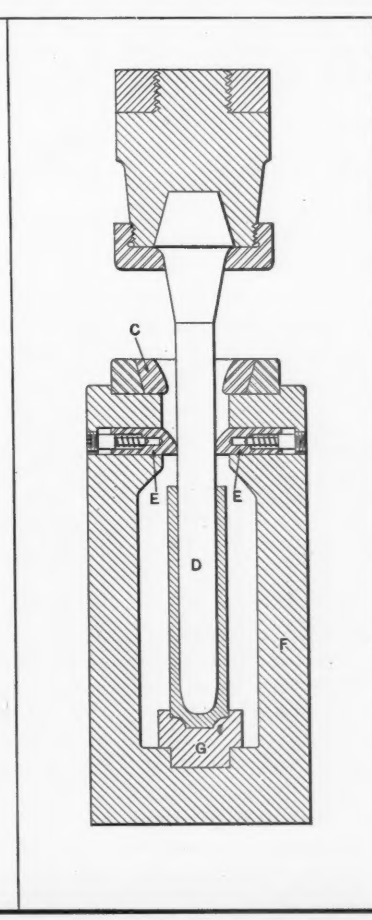

Fig. 18. Second or Hot-drawing Operation in French Method of forging Shells

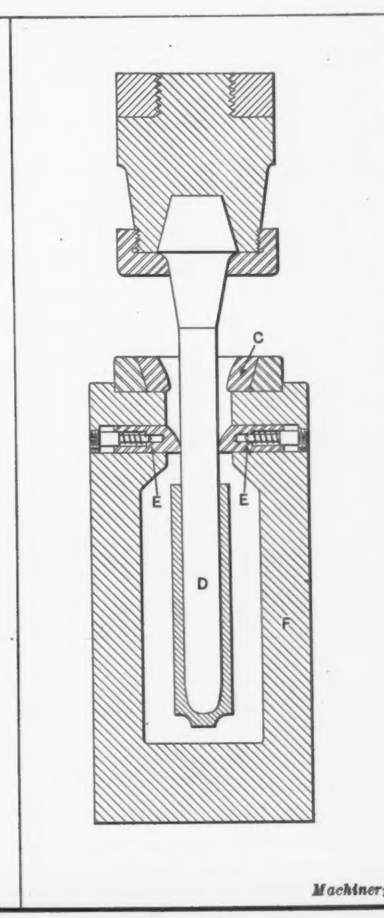

Fig. 19. Third or Cold-drawing Operation in French Method of forging Shells

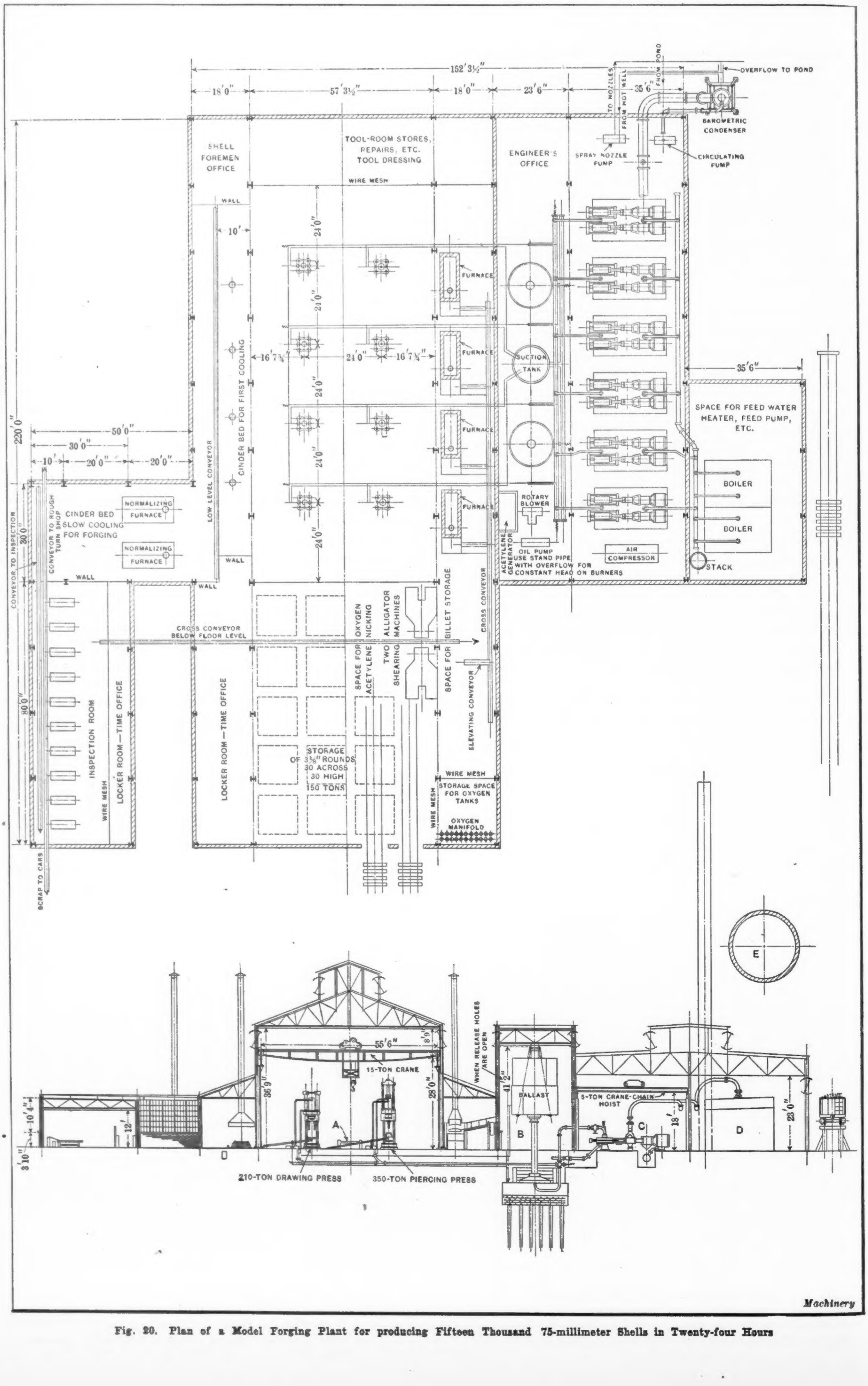

Fig. 20. Plan of a Model Forging Plant for producing Fifteen Thousand 75-millimeter Shells in Twenty-four Hours

tached from descending. The plunger then comes down with the shell and pushes it through the two dies at *E*. The shell forging is drawn to a smaller diameter in each of the two dies. The full length of the shell after having been drawn through these dies is about 14 inches. When the plunger returns on its upward stroke, the shell is removed from it by strippers *A*, shown in Fig. 10, which is a plan view of the stripper plate; holes *C* are the holes for the forgings and plungers. These strippers are backed up by springs. When the plunger and the shell descend, the strippers are pushed back, owing to the slanting shape of their face, as indicated at *B*. When the plunger again ascends, however, the lower edge of the end of the stripper catches against the edge of the shell and strips it off, the shell falling through the hole *F*, Fig. 9. As soon as the plunger has ascended after the second part of the second operation, a cup, filled with water and shaped similarly to the shell, is passed up so that the plunger is immersed in it for cooling. The water that runs over the sides of the cup as the plunger is immersed cools the sides of the dies beneath. Die *B*, Fig. 9, is shown in detail in Fig. 13, and dies *E*, in Fig. 14.

Gages Used for Inspecting Shell Forging

The gages used for inspecting the shell forging when cold are shown in Fig. 16. Gage *A* is a direct-reading gage for inspecting the inside of the shell. The end *E* is inserted in the shell, and the readings on the graduations on wing *F* are compared with the drawing of the shell. This gage is especially useful for finding pockets on the inside of the shell.

Gage *B* is a maximum and minimum gage for the inside diameter of the shell mouth. It is made from a flat piece of stock, as shown. The end at *H* must pass into the shell, while end *J* must not pass. Gage *C* is a "Go" or maximum gage for the outside diameter of the shell. In order to limit the amount of machining to be done, the shells must not be larger in diameter than is determined by this gage. Gages *D* are intended for testing the inside taper of the shell. The end of the gage must not touch the bottom of the shell. Two gages are provided for different parts of the inside taper of the shell.

The gage used for testing the thickness of the base or the bottom of the shell, as well as the total length, is shown at *K*. Here *L* bottoms on the inside of the shell, while the other leg passes along the side outside the shell. When the shell base is of the right thickness and the shell of the right length, the base surface of the shell must come within the limits indicated at *M* and the length must not pass beyond the line *N*.

One more gage is used for testing the concentricity of the shell. This consists of a mandrel *G*, Fig. 15, provided with a movable head *H*, which is supported on rod *J*. This head contains three radial pins *K*, which are forced out by the taper on rod *J*, thus centering the shell at the top. On the mandrel *G* is turned a collar which centers the shell at the mouth. The shell is placed on the assembled mandrel with the mouth or open end down. In the base *F*, into which the mandrel is set, is a post or arbor on which the gage collar *A* is assembled, so that it is free to turn in a horizontal plane and also is movable up and down on the arbor. This up and down movement is controlled by the spiral spring *L*, which is supported on the lower end by collar *D*. The pins *E* keep the parts together. The shell is rotated on the mandrel, and collar *A* is pushed down into contact with the base of the shell. While the shell is given one complete rotation, the gage point on the collar *A* must, at no position, slip down off the base of the shell. In other words, the gage point on *A* determines the maximum radius of the shell.

The preparation of the preceding article was made possible through the courtesies of G. C. Brainard, general manager, and J. D. Corcoran, factory manager, of the Hydraulic Pressed Steel Co., Cleveland, Ohio, as well as by the assistance of S. S. Daykin, engineer of tests, who aided in compiling the information given.

French Method of Forging 75-millimeter Shells

In this connection, it may be of interest to outline briefly the method used in France for the forging of 75-millimeter shells, as this method differs from that used by the Hydraulic Pressed Steel Co. This process is of especial interest to American readers on account of the fact that its application is being considered by several manufacturers of forgings in this country; among others, by the American Shell Co., Paterson, N. J. Should the latter company decide to build a forging plant to produce its own forgings, a matter which is contemplated, use would be made of a modification of the French process.

This process consists briefly of three operations—a piercing operation, a hot-drawing operation, and a cold-drawing operation. By these processes, shells can be produced having so good an internal finish and such accurate inside dimensions that no further machining is required on the inside. Furthermore, only a finish-turning operation is required on the outside, the rough-turning operation being eliminated. It is possible to obtain the required results by simply using the piercing and hot-drawing operations, but an improved shell is produced by adding the cold-drawing operation.

Diagrammatical views of the piercing, hot-drawing, and cold-drawing tools are shown in Figs. 17, 18, and 19. In the first or piercing operation, Fig. 17, no outside die is used; the punch *A*, mounted at the bottom, is stationary, while the punch *D* comes down from the top, pressing the forging downward against the punch *A* and forcing out the sides in an umbrella shape. The forging is then taken to the hot-drawing dies in Fig. 18, where it is drawn through die *C*, which forces it onto the plunger *D* so that the inside of the shell will conform exactly to the shape of the plunger. In passing downward, the shell pushes the strippers *E* outward against the spring pressure. As soon as the shell has passed, the strippers close in upon the plunger, and when the latter returns, they strip the shell from it. The shell is taken out through an opening in the side of the die frame *F*. After the completion of the second operation, the shell is sand-blasted and cleaned from all scale. The best results are then obtained by subjecting the shell to a cold-drawing operation in the die shown in Fig. 19. This differs from that in Fig. 18 only in that there is no bottom die *G*. While it is possible to obtain a satisfactory shell forging by simply using the first two operations, the adding of the cold-drawing operation is recommended; however, only the first two operations were generally used in France until recently, when the cold-drawing operation was added. After the cold-drawing operation, the outside is only slightly over size, so that a finish-turning operation only is required. Furthermore, the cold-drawing process improves the surface of the metal considerably, making it firmer and stronger.

Lay-out of Forging Plant

Fig. 20 shows a lay-out of a forging plant which may be considered a model design. This is a forging plant planned and arranged by the American Shell Co., for its contemplated extension, the capacity of the plant being fifteen thousand 75-millimeter shell forgings per day of twenty-four hours. This plant includes conveyors for mechanically handling the material and the shell forgings, and an equipment for heat-treating or normalizing the forgings so as to remove all the strains of the metal after the forging operations are completed. This normalizing of the steel causes a refinement in the structure of the grain and increases the elastic limit.

The piercing presses are of 350 tons capacity, and the drawing presses of 210 tons capacity. At *A* is shown an elevated platform 2½ feet above the floor level and 6 feet wide, which provides for a clear passageway. Gravity conveyors for the hot forgings pass underneath this platform from the piercing to the drawing presses. Hand trucks carrying dies and tools use the platform. At *B* are shown the 21-inch by 15-foot hydraulic accumulators, which work at a pressure of 1500 pounds. Ore is used for ballast. At *C* are shown steam pumps which are triple-expansion, condensing, and work with a 26-inch vacuum, producing 1500 pounds per square inch discharging pressure. The steam pressure is 140 pounds per square inch. The steam cylinders are 18, 29, and 46 inches in diameter, respectively, and the stroke is 24 inches. The pump cylinder is 6 inches in diameter. At *D* are shown boilers of 450 horsepower rated capacity, each producing steam at a pressure of 160 pounds per square inch. The circle at *E* indicates a concrete fuel oil storage tank having a capacity of 80,000 gallons, the daily demand for the plant shown being 4000 gallons.

CONTOUR- AND RADIUS-MEASURING INSTRUMENT

UNIVERSAL TYPE OF INSTRUMENT FOR MEASURING IRREGULAR PROFILES, RADIUS GAGES, AND CONTOURS THAT CANNOT BE TESTED BY ORDINARY MEASURING DEVICES

THE accurate measurement of contour and radius gages is often very difficult, if not impossible, when ordinary measuring appliances are utilized. The contour- and radius-measuring instrument to be described is designed especially for the accurate measurement of irregular profiles, circular edges, or various combinations of straight and curved sections. This instrument was designed by J. H. Wilhelm for the Frankford Arsenal. An instrument of this general type was required for measuring the contour of rifle bullets (which must conform within close limits to a given size and shape), but the instrument as finally made is a universal type that is applicable to all kinds of profile measurement.

This instrument (see Figs. 1 to 3) is equipped with a microscope having cross-hairs or lines which are adjusted to coincide with the different edges and intersecting points on the part being measured, and these hair lines, in conjunction with the graduations and Johansson gages used, indicate the amount of error or enable measurements between different points to be taken. The microscope *A*, Fig. 2, is mounted upon a cross-arm or carriage *B*, which is pivoted at each end to holders *C*. The fulcrum pins are adjustable along the holders, and they are accurately located in any desired position by Johansson blocks. These pins are reduced one-half their diameter, and by inserting different combinations of gage-blocks, any radius from 0 up to 6 inches can be measured. For instance, if 0.020-inch blocks are inserted in each holder, a radius of this dimension can be measured accurately. The gage-block holders are pivoted to brackets *D* attached to slide *E*, and the outer ends of the holders are connected by a tie-rod. The horizontal slide *E* provides a lateral adjustment of six inches, the micrometer and the straightedge at *F* (which is integral with slide *E*) moving in parallel planes. This adjustment is effected by a rack and pinion operated by handwheel *G*. The screw *H* is used for making fine adjustments after a split nut is engaged with it. This fine adjustment is indicated by a scale and vernier at *J*, and Johansson blocks may also be inserted at *K* when a very accurate movement of the slide is necessary. The horizontal slide is locked in position by clamping screw *L*.

The microscope is carried by a slide which can be adjusted at right angles to straightedge *F*. There is a total movement of two inches in this direction, and either Johansson blocks at *N* or a scale and vernier may be used when making the adjustment, which is effected by screw *M*. The circular movement of the microscope and its carriage is indicated by dial *O*, which is graduated to 90 degrees on each side of the zero mark, or to 180 degrees in all. By means of a vernier scale, direct readings to 5 minutes can be taken. The disk is shown in the zero position in Fig. 2 and in the 90-degree position in Fig. 3. It is held positively in the zero position by lock-pin *P*, and it may be clamped in any other position by clamp screw *Q*. When the lock-pin is in place, the hair line on the microscope coincides with a plane which is at right angles to the straightedge *F* and intersects the center line *R* on this straightedge.

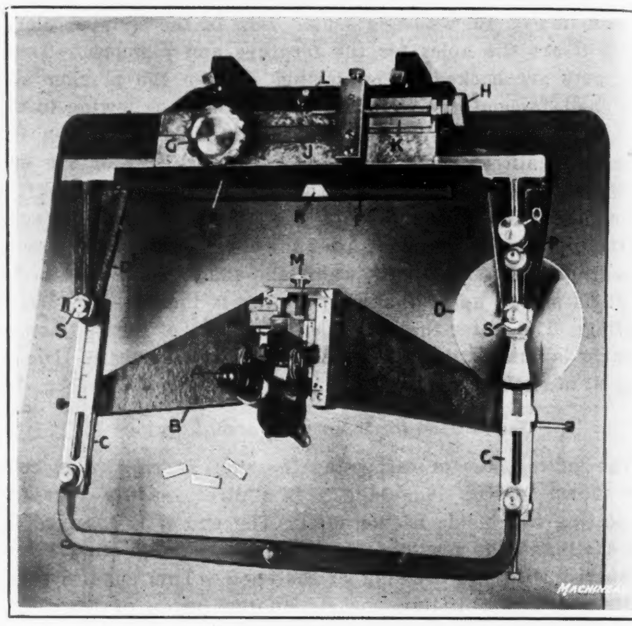

Fig. 2. Plan View of Contour- and Radius-measuring Instrument

These different adjustments and means of measurement make it possible to determine very accurately the movements of the microscope, whether the direction of motion is parallel to straightedge *F*, at right angles to it, or along a circular path. The microscope is provided with six objectives, the three shown in position being interchangeable with three others. By using these different objectives, the magnification may be varied from 20 to 100 times. In some cases, high magnifying power would not be suitable, because irregularities in the edge or contour of the part being inspected would be enlarged to such an extent as to make it difficult to follow readily the general outline; moreover, the constantly changing focus due to pronounced irregularities would interfere, so that a relatively low magnification is desirable for the rougher classes of work, and a more powerful objective for exceedingly fine work.

Before using the contour- and radius-measuring instrument, a glass scale having graduation lines spaced 0.001 inch apart is placed on the surface plate and the microscope is focussed onto it. The microscope is fitted with an adjustable eye-piece (not shown in the illustration) and the hair line is traversed from one of the graduations on the glass scale to the next one, and the reading of the graduated dial of the adjustable eye-piece is noted. If this is a fractional reading, the microscope is adjusted vertically and focussed again; another reading is then taken, and if it is necessary other readjustments are made, until a movement of the hair line from one graduation line to the next one gives a reading on the eye-piece dial equal to an even or whole number of divisions. The dial then gives direct readings and may readily be used for measuring errors in gages or other parts under observation.

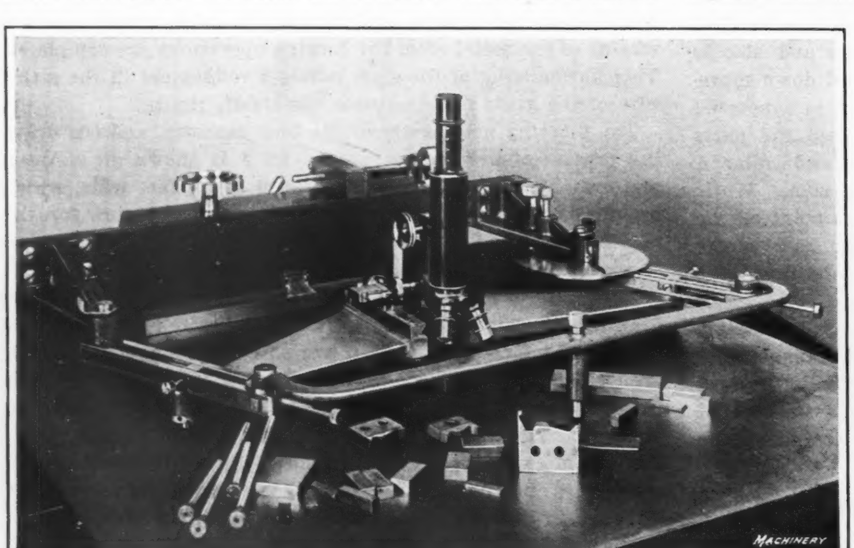

Fig. 1. Contour- and Radius-measuring Instrument for testing Accuracy of Irregular Profiles or Circular Edges on Templet Gages, etc.

The work to be inspected is placed on the surface plate which forms the base of the instrument and is located, in some cases,

with reference to the straightedge F. For instance, it may be necessary to have a straight section of a contour gage parallel with this straightedge. The work can easily be set in this parallel position by simply adjusting it until the intersection of the hair lines follows the straight section when slide E is traversed laterally. If a contour gage or templet is being measured, the distance between parallel edges or surfaces lying in different planes is, as a rule, measured by moving the slide upon which the microscope is directly mounted and also by adjusting the main slide E, as may be required. As previously mentioned, the extent of these movements may be determined accurately either by vernier scales or the Johansson gage-blocks. For instance, in testing the accuracy of the profile gage shown diagrammatically in Fig. 4, the measurements indicated by the letters a, b, c, etc., would be taken first, since they represent distances between important surfaces and intersecting points. It might be necessary also to check angle x. This could be done readily by the method shown on an enlarged scale at the lower part of the illustration. The hair lines are first set to coincide with the angular edge as at A, and then the microscope is adjusted to some position B. An adjustment at right angles is next made, the movement y in this direction equalling dimension z times the tangent of the required angle.

When measuring the radius of an arc or circular edge, the pivots of the cross-arm B, Fig. 2, which carries the microscope are set in the zero position or in line with the fixed pivots S. The intersecting point of the hair lines is then set in line with the center of the arc, this center being located by adjusting the microscope longitudinally and laterally with reference to locating points on the work and according to dimensions on the gage drawing. After the microscope has been set in this way, the cross-arm pivots are adjusted to the required radius by inserting Johansson blocks in the holders C; then, as the holders swing about pivots S, the intersecting point of the hair line should follow the circular edge of the gage. This test not only shows an error in the radius, but also an error in the location of the circular edge. The amount of error may be measured by the graduated dial of the adjustable eye-piece previously referred to. If the angle included by the arc is required, it is simply necessary to note the reading on dial O as the cross-arm traverses from the beginning of the arc to the point of tangency or to the end of the circular section.

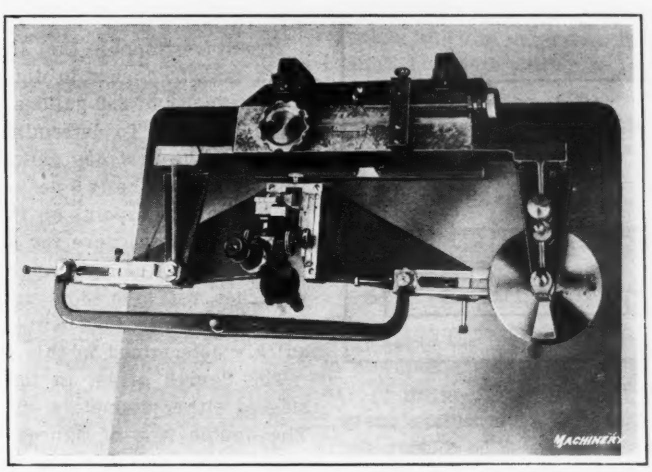

Fig. 3. Microscope and its Carriage set in 90-degree Position

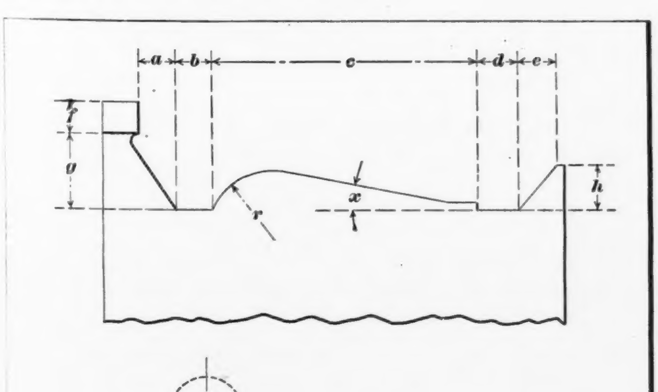

Fig. 4. Diagram showing Method of using Contour- and Radius-measuring Instrument

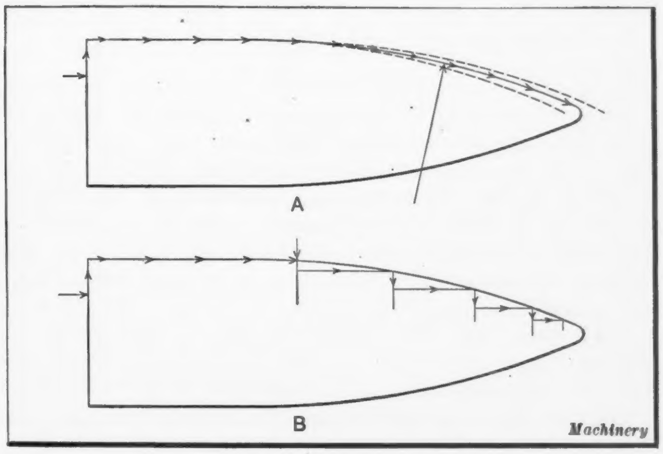

Fig. 5. Two Methods of measuring Rifle Bullets

When this instrument is to be used for measuring parts of circular cross-section (such, for example, as rifle bullets) the microscope is first focussed on the point of tangency or with reference to a horizontal plane intersecting the center of the object to be inspected. As it would be difficult to focus on the point of tangency or on the side of a cylindrical part, the proper focus is obtained by placing on the surface plate Johansson blocks having a total height equal to one-half the diameter of the part to be tested. The microscope is then focussed on the surface of the upper block. Fig. 5 illustrates two methods of measuring the contours of rifle bullets. The method shown at A consists in measuring from the base of the bullet to the point of tangency, then measuring the radius of the arc after locating the microscope directly over the center of the arc, and adjusting the cross-arm pivots the required amount. The dotted lines indicate how errors either in radius or in the proportions of the bullet may be detected. What might be defined as the "step method" is illustrated at B. After measuring from the base to the point of tangency, the contour is checked by a series of lateral and longitudinal movements as the illustration shows. The universal adjustment of this instrument makes it possible to test the accuracy of practically any profile for comparing it either with a master gage or with prescribed dimensions. F. D. J.

* * *

According to figures collected by John Lind, assistant secretary of the National Lumber Manufacturers' Association, one large automobile concern, in 1913, lost $2,500,000 in hiring, temporarily training, and then losing or dismissing 52,445 men in order to keep a constant working force of 13,000 men. This may be an extreme condition, but it indicates the cost of changing men and shows that it pays to keep a steady permanent body of labor. This large labor turnover has now been greatly reduced by this firm. A Pittsburg corporation with a permanent force of 16,000 men had a labor turnover, in 1916, of 187 per cent. Experts estimate that it costs from $40 to $150 to hire and train a new workman; hence this amount is lost if he is dismissed or becomes dissatisfied and leaves of his own accord.

* * *

Figures published by the Bureau of Labor Statistics indicate that there is an increase of 1,426,000 in the number of women employed in the United States in 1917 over the number employed in 1914. Women have replaced 1,413,000 men since 1914; 530,000 more women are now in the industries than in 1914, and 214,000 additional women are in government service.

IMPROVED METHOD FOR FINDING CONTENTS OF CYLINDRICAL TANKS

BY CARLO M. EYSTER[1]

On page 644 of the March number of MACHINERY, the writer described a graphic method of finding the contents of cylindrical tanks, but that method has since been displaced by two improved charts. The problem, as explained in the previous article, is to determine the height of various quantities of liquid in a cylindrical tank, placed as shown in Fig. 1. The heights thus obtained are used for graduating wooden gage sticks that measure, roughly, the contents of cylindrical oil and gasoline tanks; the graduations read in even number of gallons. These sticks are divided into from twenty to one hundred parts, depending on the tank size.

The first of the improved charts, Fig. 2, is the original curve with the addition of a series of percentage curves. The single curve in the right-hand part of the diagram is constructed on the principle that there is a constant relation between the quantity of liquid in any tank and the height to which this quantity will reach. In other words, the per cent of total capacity and the per cent of diameter are in a constant ratio at any point in all tanks. This is the curve shown in the March number and is explained in detail there. The percentage curves in the left-hand part of Fig. 2 eliminate any multiplying in changing from per cent of diameter to height, in inches, and are based on the fact that a percentage curve is a straight line. Percentage curves could also be constructed with the percentage of the total capacity as one coordinate; the latter curves, however, would lie below the main original curve in the same manner as the percentage curves shown lie to the left. Then, given a tank of a certain capacity and diameter to compute the height to which a given quantity will reach, all values can be read off directly in gallons and inches.

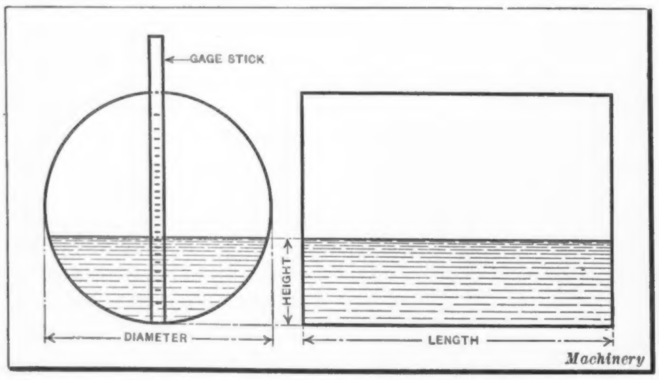

Fig. 1. Use of Gage Stick in Cylindrical Tank

The second chart, shown in Fig. 3, is simpler and more accurate than the first. The abscissa is the percentage of the total capacity, as before, but instead of each per cent being equal in length, as in the previous curves, the spaces are laid off as they will appear on a gage stick. The divisions decrease in length as they approach the center and increase after passing it; their length can be computed from the tables given in any handbook for the areas of segments of a circle.

The original chart of Fig. 3 was constructed by assuming a tank 100 inches in diameter and 100 gallons capacity in order to change readily from units to per cents. Values were computed for the height, in inches, to which each additional gallon of liquid would reach. Each of these quantities was then considered a percentage of the total capacity, and laid off a distance, from the left, on the horizontal base line equal to the height, in inches, just computed. The spaces on the horizontal base line, or abscissa, as they are constructed, are the divisions of the diameter to which the various percentages of the total capacity will extend. Since these divisions, although labeled percentages of capacity for convenience in applying the chart, are in reality the percentages of the diameter, straight oblique lines can be constructed as shown, and these are the working curves. The figures at the right of Fig. 3 represent the diameter of the tank and the graduations to be used on the gage stick, in inches.

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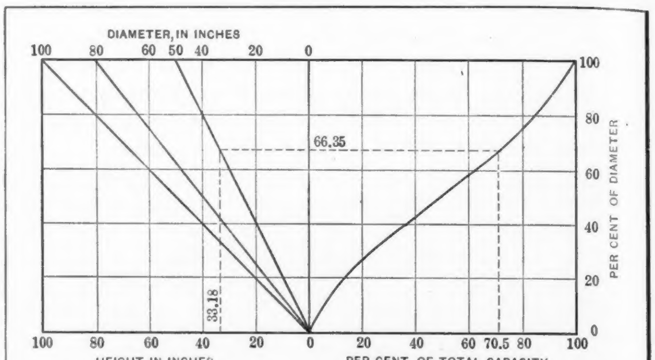


Fig. 2. Chart for graduating Gage Sticks

It will be perceived that per cent curves can be constructed in Fig. 3 also, so that quantities expressed in gallons can be read off directly without having to deal with the percentage of the capacity. The reason that this is not done in the case illustrated is that the diameters and lengths of tanks are all in even inches, so that the capacities of the tanks vary somewhat from the nominal rating. Thus, a tank specified as a 1000-gallon tank may contain 1018 gallons, since the volume is a function of both length and diameter. There would thus be an endless number of total capacity lines, whereas the diameters are all covered by perhaps ten curves, because standard-size heads are used.

Example—Suppose that it is desired to lay out a gage stick for a tank 50 inches in diameter and 100 inches long, with a total capacity of 850 gallons, the gage to be graduated in units of 20 gallons. To determine, for instance, to what height in the tank the first 600 gallons will reach, divide 600 by 850; this shows it to be 70.5 per cent of the total capacity. Drawing a line from this point on the base line until it intersects the straight oblique curve for a 50-inch diameter tank, and then drawing a line at right angles to the value for height in tank, in inches, will give 33.18 inches as the length on the gage stick at which 600 gallons will be indicated. Each value can be quickly determined in this manner.

The figures given, in inches, in both curves can be considered either diameters of the tank or heights of the liquid. The double row of figures illustrates what can be done in order to obtain more accurate readings, since the smaller values, running from 0 to 25 inches, will give closer results than those from 0 to 100 inches, and should be used for tanks less than 25 inches in diameter. The oblique percentage curves should never be more than 60 degrees nor less than 30 degrees from the horizontal for the sake of accuracy. Both of these curves are so broad as to be applicable to any depth in any tank of any diameter and length.

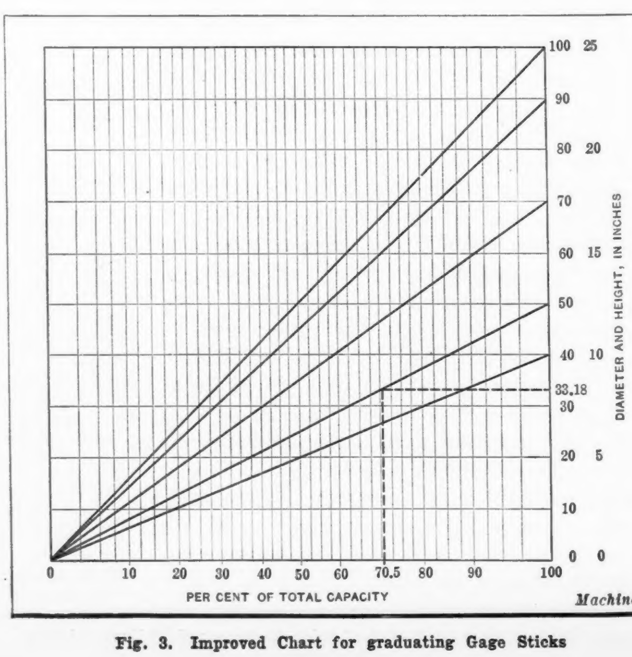


Fig. 3. Improved Chart for graduating Gage Sticks

CONSERVING MECHANICAL ABILITY

BY A. H. J.

The time is ripe for mechanical men in this country to get together and in some way draw the attention of the Government to the urgent necessity of exempting from active service the machine and tool designers, toolmakers, and gage-makers, who are proving more and more every day that it is part of their job to win this war. The proposition can be taken up in much the same way as the medical profession obtained its exemptions, for the mechanical men of the country are just as valuable in their line as the medical men are in theirs. Furthermore, if mechanical ingenuity and thought had not been applied to the medical profession it would not be in as advanced a stage as it is. No surgeon would attempt a capital operation with instruments of crude manufacture; neither could he use the X-ray, pulsometer, testing microscope, or any of his other instruments if it had not been for the toolmaker or designer whose ingenuity made it possible for these instruments to be manufactured in such a high state of perfection. There is little doubt that of the millions of articles manufactured today in this country, 99 per cent were invented or improved by mechanical men.

If this is true, which can easily be determined by an investigation, why is it that the Government should take such constructive men away from their work which has required years to learn and make destructive, non-producing men out of them? Is it of advantage to this country to reduce the high production and high standard of quality for which we are known throughout the world? For that is what we are doing when we draft into the army men trained to keep this production and quality at its present level.

It has been stated that in the first 5 per cent of the draft they received at Camp Upton twenty-five designers, six mechanical engineers and twenty-five or thirty mechanics, such as toolmakers, gage-makers, machinists, etc. If each mechanical engineer is a graduate from a college having a four-year course, but without the practical experience, for the six men this will mean twenty-four years of preparation. In order to be a designer, a knowledge of machine shop practice is essential. Assuming that the designer serves an apprenticeship of four years, and in addition has from six to twelve months' training in mechanical drawing and from two to three years on detail work, according to ability, the preparation of a designer requires about six to eight years; to be conservative, say five years. For the twenty-five designers this means 125 years of preparation. Machinists serve a four-year apprenticeship; toolmakers, who are graduate machinists, five to six years; gage-makers, five to seven years. As a result, considering five years as the average instruction period required by the mechanic, the time spent by these men preparing for their work is:

25 mechanics	125 years
25 designers	125 years
6 mechanical engineers	24 years
Total	274 years

This does not mean a staff of "dyed-in-the-wool" practical, experienced men, but men who will, after the war is over, help in the reconstruction period.

Under present methods of warfare in Europe it would appear that we might be able to use about two out of every four or five men if they all came back; but, assuming that we lose two out of five men, one being killed in battle and one maimed, the loss is:

2 mechanical engineers	8 years
10 designers	50 years
10 mechanics	50 years
Total	108 years

In other words, 108 years of mechanical skill is lost. Can you imagine what a staff of men like this in any plant in the country could do to produce articles that are urgently needed? The same men, working under an experienced engineer, could do more effective work in a ten-hour day at a plant on government work than they could do in a month in the trenches. These figures do not include men who have had ten, twelve, or fifteen years practical experience, and there are some men at Yaphank who have had a number of years of experience in this line of work.

It is not the writer's intention to give the impression to men outside of the mechanical field that all mechanical men should be exempted. It is strongly urged that the Government mobilize all these producing men in a great army and send them throughout the country to plants where they will be able to do their best in speeding up the manufacture of the thousand and one articles necessary to the successful prosecution of the war; and when the reconstruction period comes, they will be in a position that will require no readjustment. France and England realize the great mistake they made in letting their mechanical men go to the front, and have had to come to this country for their supplies. If we make this same mistake, there is no source to which we can turn, and so will have to take the consequences.

There are at present, to the writer's knowledge, about a dozen concerns around New York that are doing government work, but have only half enough men to get out the work, because of the scarcity of men. One firm in July, 1917, inserted advertisements for draftsmen in two New York papers for one week and only received twelve replies. Out of these twelve, about five applicants appeared promising, so letters were sent to these asking each to call. Four of the men called. One did not think he was able to handle the job, one man was capable, and the other two men were not experienced in that branch, but were willing to learn. So the result of one week's advertising was one capable man and two green hands. This firm pays its men well and the men in charge have good reputations in handling men, yet it is unable to obtain enough men. If this is true concerning conditions a short time ago, what will it be a little later?

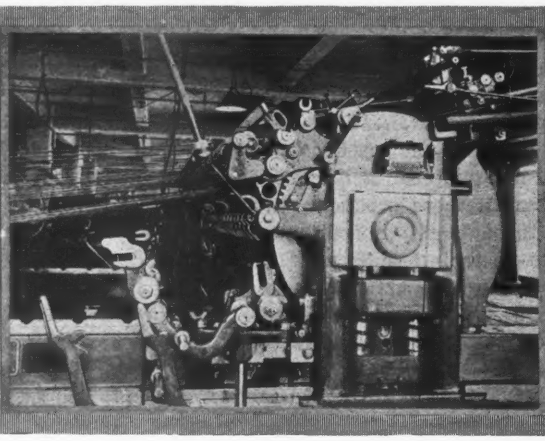
* * *

PULVERIZED COAL AS A FUEL[1]

Owing to the fuel famine, the use of pulverized coal as a fuel is now being carefully studied. Practically any coal can be burned in the pulverized form with a proper furnace and burning equipment, but each application must be governed by the quality of the fuel available. Generally speaking, however, the coals that will give the most satisfactory results are those having an ash content of less than 10 per cent, volatile content between 30 and 40 per cent, and a fixed carbon content between 40 and 50 per cent. The sulphur content should be low, although coal with a sulphur content as high as 4½ or 5 per cent has been satisfactorily burned. In the pulverized forms, many coals that are now thought unsuitable will be made available for use, especially the various grades of lignites and low-grade coals of the Northwest.

The value of this form of fuel has been recognized by the steel industry which today is using about two million tons annually, in its open-hearth, heating, puddling, annealing, and forging furnaces, and soaking pits; between thirty and forty million tons have been used in the manufacture of Portland cement; for the desulphurizing and roasting of various grades of ores and the nodulizing of flue dust, one installation alone requires 120 tons a day; and one of the many electrical power plants that use this fuel burns over 100,000 tons annually. Pulverized coal is also successfully used in burning lime in rotary kilns for making oxide of lime for use in the open-hearth furnaces and also for burning dolomite to replace magnesite used for furnace linings. This fuel is so abundant that in the anthracite field alone from eight to ten million tons are annually pumped back into the mines to fill up old workings, and around steel plants there are large quantities of waste in the form of coke breeze. Tests made with one furnace of the Calumet Steel Co. showed a saving of $6019 in one year. With coal at $2.65 per net ton and oil at 3 cents a gallon, a daily saving in fuel of 49 per cent was made. In addition, at least 2 per cent less scale was formed.

[1]Abstract of a paper by Henry G. Barnhurst, read before the Cleveland Engineering Society



Ingenious Mechanical Movements

By Franklin D. Jones[1]

Second Installment of an Article on Mechanisms for Transmitting, Modifying, and Controlling Motion to Secure Changes of Velocity, Direction, and Time of Action[2]

THE design of a mechanism for changing rotary motion to rectilinear or straight-line motion, or vice versa, may depend upon the kind of motion required, the amount of power to be transmitted, or other considerations. The crank and connecting-rod is not suitable for some classes of machinery, either because of the irregular motion imparted to the driven slide or cross-head by a revolving crank, or because such an arrangement would require too much space in case a long stroke or traversing movement were necessary for the driven member. Some of the most ingenious mechanisms for converting rotary motion into rectilinear motion are found on printing presses of the flat-bed or cylinder type. When presses of this general class are in operation, the sheets to be printed are carried around by a revolving cylinder so that contact is made with a flat form on the press bed, which moves horizontally beneath the cylinder. This cylinder makes one revolution during the printing stroke and a second revolution while the press bed is being returned. The rotation of the cylinder is continuous in one direction, and it is imperative that the cylinder and press bed move exactly in unison. The circumferential velocity of the cylinder should equal the linear velocity of the bed, because any relative motion would cause slurring on the printed sheets and it would be impossible to obtain sharp, clean-cut impressions. As the cylinder revolves at a uniform speed, obviously the mechanism for driving the bed must be designed to give a uniform motion while the impression is being made. Several press-bed motions are provided with a driving gear which rotates continuously in one direction and is located between parallel racks, and so arranged that it can be engaged with first one rack and then the other, in order to reverse the motion of the bed to which the racks are attached. With mechanisms of this class, one rack is first traversed past the gear; when the gear and rack are entirely disengaged, the gear is shifted axially far enough to align it with the other rack. While this shifting movement takes place, the motion of the bed is arrested, and it is reversed by some auxiliary mechanism which moves it far enough to bring the other rack into engagement with the driving gear. Press-bed motions of this general type differ principally as regards the method of moving the press bed at the ends of the stroke, at the time when the driving gear and rack are disengaged.

Crank Type of Reversal for Press-bed Motion

A mechanism of the double-rack and shifting-gear type, such as is applied to the Miehle flat-bed or cylinder presses, is shown diagrammatically in Fig. 16. In order to time the motion of the cylinder and bed properly, the cylinder is connected by gearing and suitable shafts with gear *A*, which transmits motion to the bed; therefore, the press-bed motion must be designed to reverse the movement of the bed without reversing the motion of gear *A*, since this gear rotates in unison with the cylinder or continuously in one direction.

This driving gear *A* is mounted between parallel racks *B* and *C*, both of which are attached to and travel with the bed. The distance between the pitch lines of these racks corresponds to the pitch diameter of the driving gear *A*. The racks are not directly in line, but are offset as shown by the end view, so that, when the gear is in mesh with one rack, it will clear the other. The lateral movement of gear *A* for aligning it alternately with racks *B* and *C* is derived from cam *D*, which transmits motion by means of a lever and yoke engaging the gear hub.

When the press is in operation, the bed is moved in one direction by the engagement of gear *A* with rack *B*, and in the opposite direction by gear *A* meshing with rack *C*. If gear *A* is revolving in a clockwise direction while in mesh with rack *C*, the latter and the press bed (the motion of which is constrained by guides) will move toward the left. When the press is in motion, this movement toward the left continues until the rack is entirely out of mesh with gear *A*; just before the disengagement of gear *A* and rack *C*, the crankpin *E*, which is provided with rollers, comes around and enters between the parallel faces of a fixed reversing shoe *F* and a swinging or movable reversing shoe *G*. The fixed shoe is rigidly attached to the press bed and rack frame, whereas the movable shoe is pivoted and is free to swivel. This swinging reversing shoe has a pin on its lower side (not shown) which engages a slot or cam that controls its swinging movements. As soon as rack *C* has moved far enough to the left for shoe *G* to clear the crankpin, the cam swings the shoe inward so that crankpin *E* is confined

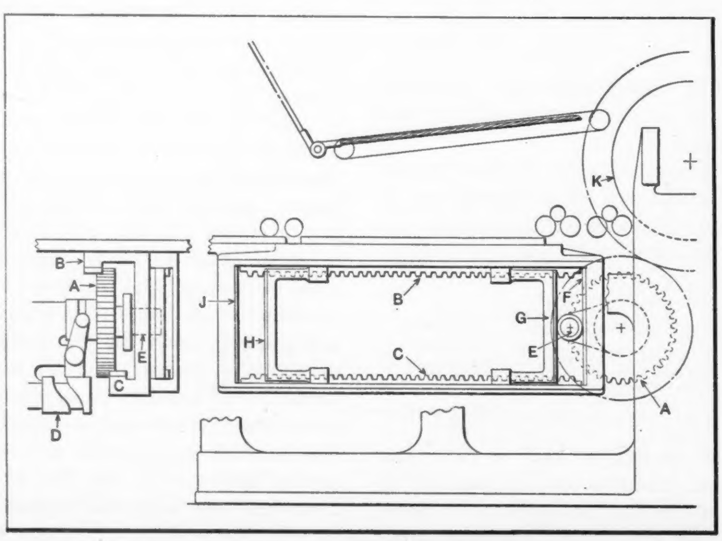


Fig. 16. Double-rack Shifting-gear and Crank Combination for traversing Bed of Printing Press

[1]Associate Editor of MACHINERY.
[2]A chapter that will be included in the author's book "Mechanisms and Mechanical Movements," to be published in the near future.

temporarily between the faces of shoes G and F, which form a vertical guide or slot. As the crankpin passes its lowest position and begins to move upward, the roller on it bears against the face of G and picks up the load as gear A moves out of mesh with rack C.

When crankpin E assumes the position shown in the illustration, the motion of the press bed is reversed, because a roller on the crankpin then engages the face of shoe F, thus moving the driven member toward the right. The motion continues to be derived from the crank independently of the disengaged gear and rack, until the crankpin has passed the top quarter or highest position; then gear A enters the upper rack B and the motion is transmitted entirely through the gear and rack until the crank again comes into action at the opposite end of the stroke. At this end, the crankpin is again confined between a swinging shoe H and a fixed shoe J. After rack B has moved out of engagement with gear A, crankpin E, which is now in its highest position, comes into contact with shoe H and continues the movement toward the right while making a quarter turn, and then reverses the motion as it swings downward against the face of shoe J. While crankpin E is controlling the motion and gear A is entirely out of mesh, this gear is shifted by cam D out of line with the rack B which it just left, and into line with rack C.

An ingenious feature of this mechanism lies in the provision of two rollers for crankpin E and the location of the fixed and swinging shoes in different vertical planes. With this arrangement, each roller is free to revolve in opposite directions as the crankpin moves along the vertical faces of the shoes. The momentum of the bed is gradually checked at the points of reversal, by air cushions or air springs. A plunger enters a cylinder at each end of the stroke and air is compressed to arrest the movement; as the air expands, it assists in accelerating the motion of the heavy bed. Provision is made for regulating the air cushion or pressure according to the speed of the press. The air cushion is a feature common to flat-bed or cylinder presses in general.

Reversal of Motion by Reciprocating Pinions

The mechanism illustrated in Fig. 17 is similar, in some respects, to the press-bed motion just described, in that the parallel-rack and shifting-gear construction is employed. The method of operating the press bed at the ends of the stroke, however, is entirely different from that shown in Fig. 16, as reciprocating pinions are used to pick up the load and reverse the motion. The uniform motion of the bed is derived from pinion A, which is constantly in mesh with gear D carried on the main driving shaft. Pinion A is located between parallel racks B and C which are attached to the press bed. These racks are offset, as in the design shown in Fig. 16, so that the pinion will clear one rack while in engagement with the other. The shifting of the pinion is controlled by cam E, which transmits motion to the pinion by means of lever F. The pinions for reversing the motion of the bed are located at G and H. The shafts upon which these pinions are mounted are connected to a heavy yoke J, which has a vertical slot or groove in which a swiveling block attached to the crank K operates. This crank is rotated by the main driving shaft, and transmits to yoke J and pinions G and H a rectilinear motion equal to the throw of the crank. This is a harmonic motion, as yoke J and the sliding crank-block operate on the same principle as the well-known Scotch yoke. The outer ends of yoke J are supported by horizontal guides, and the pinions G and H are constantly in mesh with short racks M and L, along which the pinions roll as the crank moves them to and fro.

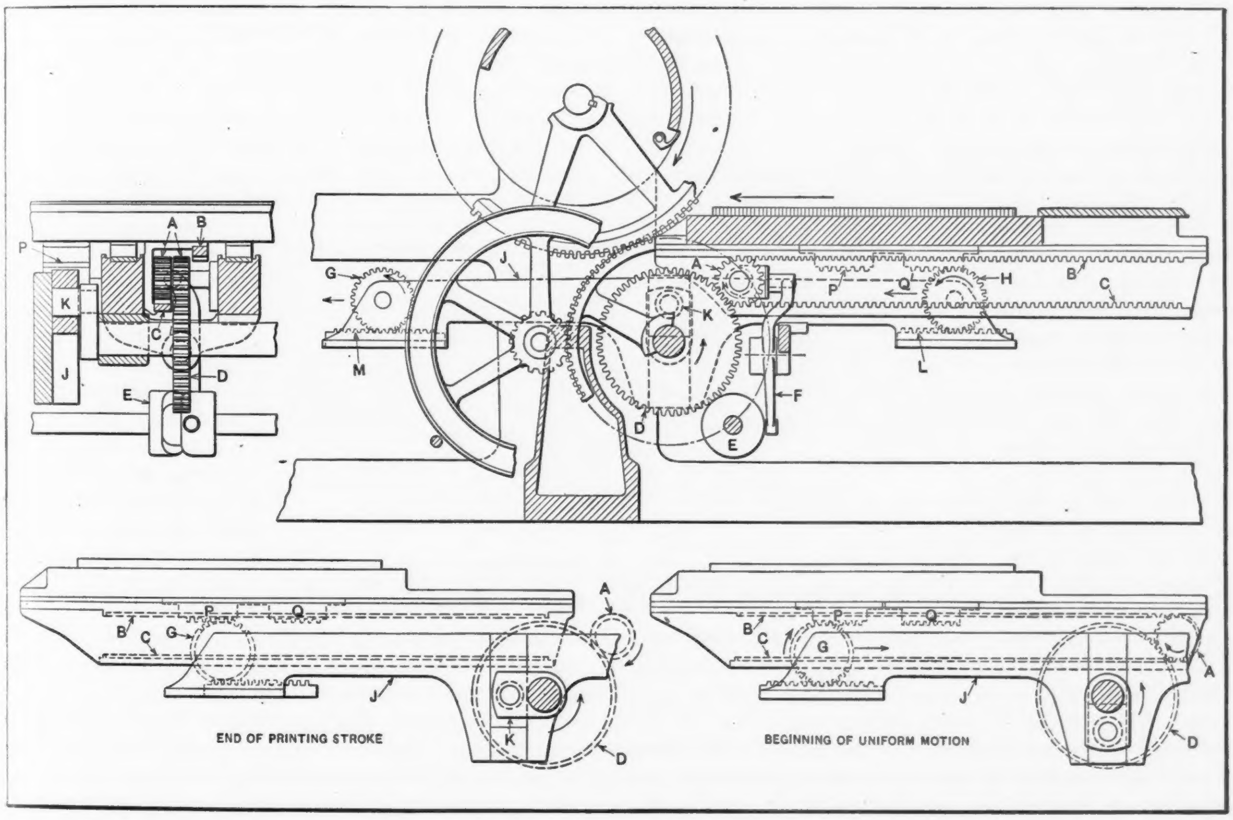


Fig. 17. Double-rack and Shifting-gear Mechanism for Press Bed having Reciprocating Pinions for controlling Motion at Ends of Stroke

The action of the mechanism will be apparent by considering the various movements that occur during a forward and return stroke. The side view of the assembled mechanism shows the press bed in the position where the driving pinion A has just come into engagement with the lower rack C. As this pinion rotates in a clockwise direction, the bed will be driven to the left with a uniform motion. The relative positions of pinion A and racks B and C are clearly shown by the end view. When the bed has moved so far to the left that pinion A is about to roll out of mesh at the right-hand end of rack C, pinion G, which, meanwhile, has been moving along its rack M, comes into engagement with another short rack P (see also end view) attached to the bed. To insure the proper engagement of pinion G with rack P, the action of crank K is so timed relative to the motion of the bed that pinion G is rolling to the left when rack P, which is also moving to the left, comes into engagement with it. As pinion A leaves rack C, pinion G, which is then in mesh with P, continues the movement of the bed toward the left until crank K is in the position shown by the diagram in the lower left-hand corner of the illustration, which represents the end of the printing

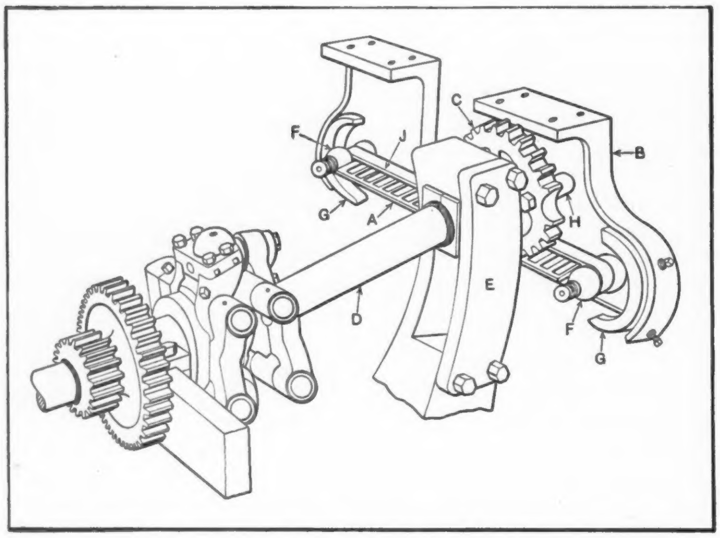


Fig. 18. Napier Motion for Flat-bed Printing Press

stroke. Further rotation of crank K in the direction indicated by the arrow causes a reversal of the rolling motion of pinion G and starts the press bed toward the right, motion being transmitted from G to rack P. While this reversal of movement is taking place, pinion A is being shifted by cam E into alignment with the upper rack B.

When crank K has moved a quarter revolution from the position it occupies at the extreme end of the stroke, pinion A comes into mesh with the upper rack B and the short rack P leaves pinion G. The view at the lower right-hand corner shows pinion A about to enter rack B, and pinion G leaving rack P. As the rectilinear motion of yoke J is harmonic, the movement of the bed is uniformly retarded as it approaches the point of reversal and is then accelerated until pinion A engages its rack, when the motion is uniform. When pinion A enters at the end of either rack, the velocity of the movement derived from crank K and the reciprocating pinion corresponds to the velocity obtained from the driving pinion A, so that there is no abrupt change of motion as the load is being transferred from the reversing pinion to the driving pinion A. As the press bed approaches the opposite end of its stroke, pinion H comes into engagement with rack Q and continues the movement for a short distance each side of the point of reversal or while pinion A is out of mesh with either rack and is being shifted, the action being the same as previously described.

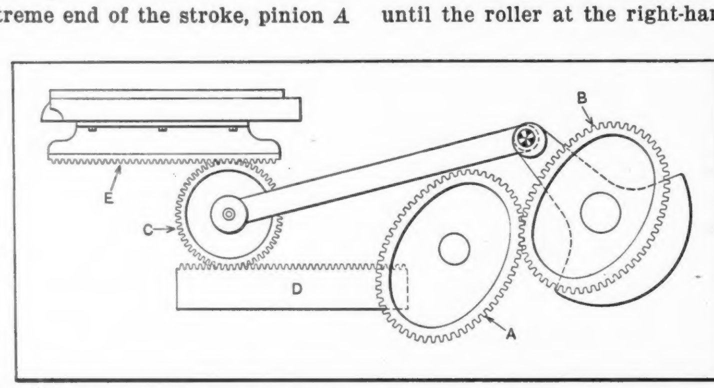


Fig. 19. Crank-driven Pinion engaging Stationary and Movable Racks for doubling Stroke

Napier Motion for Press Beds

When a gear or pinion is in mesh with a single rack and rotates in one position, obviously both the gear and rack must reverse their direction of motion at the end of each stroke. The gear, however, may rotate continuously in one direction if it is arranged to engage the upper and lower sides of a rack designed especially to permit such engagement. A mechanism of this type, known as the Napier motion and also as "mangle gearing," has been extensively used for imparting a rectilinear motion to the tables of flat-bed printing presses. The principle of the Napier motion will be apparent by referring to Fig. 18. The rack A is attached to a frame B which is secured to the table of the printing press. The rack teeth are of such a form that the gear C can mesh with the rack on either the upper or lower sides. The shaft D, upon which gear C is mounted, is rotated through a universal coupling, which permits it to swing in a vertical plane so that the gear may pass from the upper side of the rack to the lower side, and vice versa. The gear shaft is made to move in a vertical plane by a stationary slotted guide E, having a vertical slot that is engaged by a sliding block mounted on the shaft. Spherical-shaped rollers F are mounted at each end of the rack, and the gear has a socket or spherical depression formed in it for engaging the rollers each time the gear moves around the end of the rack when passing from one side to the other. Opposite each end of the rack, there are guide plates G having curved surfaces which are concentric with the rollers at the ends of the rack. Gear C also carries a roller H which engages these curved guides as the gear moves upward or downward at the points of reversal.

The action of the mechanism is as follows: If the gear is on the upper side of the rack, as shown in the illustration, and it is revolving to the left or counterclockwise, the rack will be driven to the right with a velocity equal to the motion at the pitch circle of the gear. As soon as the gear engages the roller F on the end of the rack, it begins to move downward in a vertical plane, because its motion is constrained by guide E. When the gear is in mid-position so that its axis coincides with the center line of the rack, it will have made a quarter turn, thus moving the center of roller F farther to the right, a distance equal to the radius of the pitch circle. Further movement of the gear downward causes the rack to reverse and move toward the left; the gear then operates on the under side of the rack until the roller at the right-hand end of the rack is engaged, when the upward movement of the gear takes place and there is another reversal of motion.

The total length of the stroke is equal to the distance between the centers of the rollers on the rack plus the pitch diameter of the gear. The length of the rack must equal the pitch circumference of the gear or some multiple of it, so that the rollers at the end will engage the socket or depression in the gear at the points of reversal. If a gear having two roller spaces located 180 degrees apart is used, the length of the rack or the center-to-center distance between the rollers may be some multiple of half the pitch circumference. The teeth on each side of the rack incline from the horizontal at the same angle as the gear axis when in its upper and lower positions, to obtain a full contact of the gear teeth. The gear also has a plain cylindrical shoulder on the inner side, which rolls upon a plane surface J at the base of

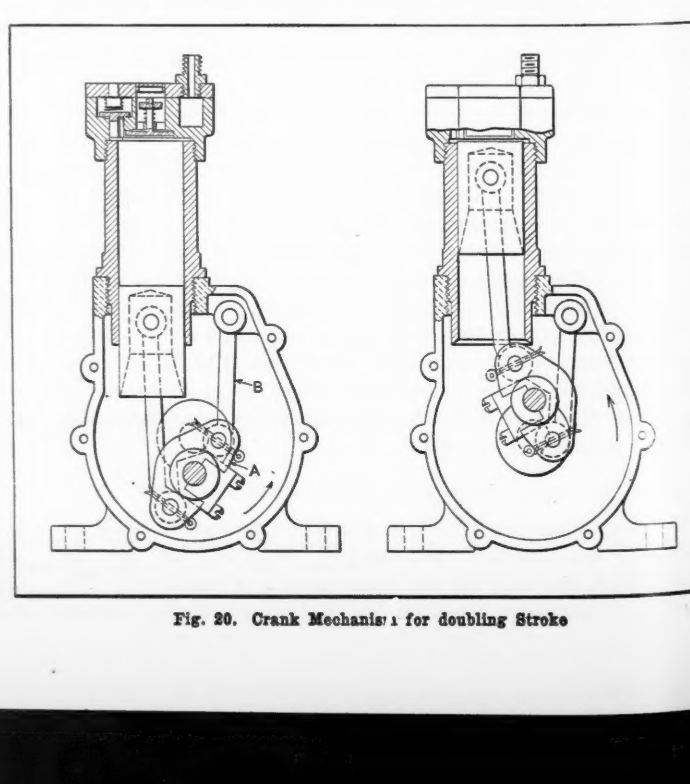


Fig. 20. Crank Mechanism for doubling Stroke

the rack, to give a smoother action than would be obtained from a gear supported entirely by tooth contact. This arrangement of gearing imparts a uniform motion to the press table, with the exception of any variation in movement resulting from a universal joint, and gives a gradual reversal of motion at the ends of the stroke. The Napier motion may be designed for any length of stroke, although the stroke remains constant, as there is no way of making an adjustment.

Crank-driven Pinion Engaging Upper and Lower Racks

A method of doubling the stroke when a crank of relatively small size is necessary, owing to a limited space or because a compact design is desirable, is by means of a stationary and a movable rack having a crank-driven pinion interposed between them. The pinion is pivoted to the end of the crank connecting-rod so that it is free to roll along the stationary rack when the crank revolves. As the result of this rolling movement of the pinion, the movable rack is given a rectilinear motion equal to twice the stroke of the crank or twice the diameter of the path described by the crankpin. This mechanism has been used for driving the beds of cylinder presses.

A modification of the plain gear-driven crank is shown in Fig. 19, which illustrates the bed motion of a two-revolution pony press. The driving and driven gears *A* and *B* are of the elliptical form in order to compensate for the motion derived from a crank rotating at uniform velocity. The driven gear *B* revolves the crank, which, in turn, transmits motion to pinion *C* by means of the connecting-rod shown. This pinion is rolled in first one direction and then the other along the stationary rack *D*, and imparts a rectilinear motion to rack *E* and the press bed. The press bed moves a distance equal to twice the distance that the axis of gear *C* moves, or four times the radius of the driving crank. The elliptical gears are so proportioned and located relative to the crank as to give a more uniform motion to the press bed than could be obtained with a crank rotating at uniform velocity. With an ordinary crank, whatever part is given a rectilinear motion starts from a state of rest, and the velocity gradually increases toward the center of the stroke and then decreases until it again becomes zero at the opposite end of the stroke. With the elliptical gearing shown, as the pinion *C* approaches either end of its stroke and the crank advances toward the dead-center position, the long side or radius of the driving gear comes into engagement with the driven gear and increases its velocity, and also the

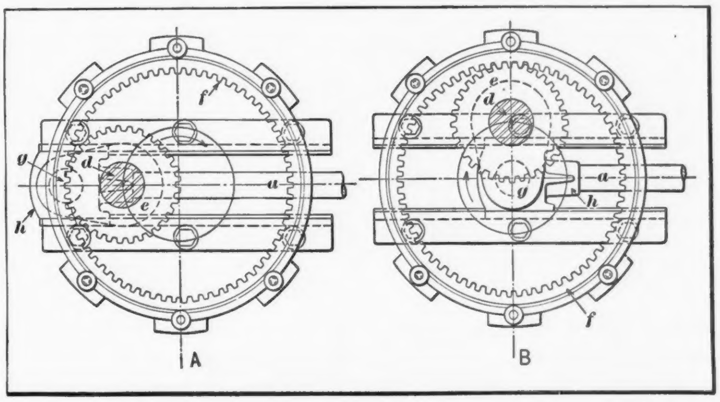


Fig. 21. Planetary Gear and Crank from which Reciprocating Motion is derived

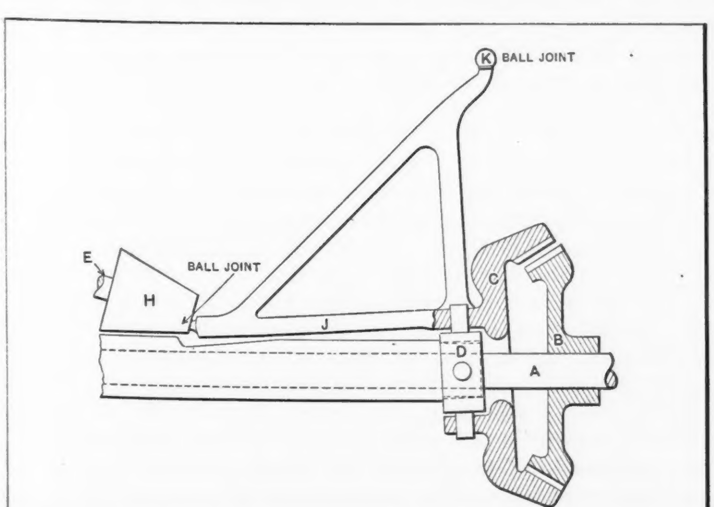


Fig. 22. Planetary or "Wabble" Gearing for producing Rapid Reciprocating Motion

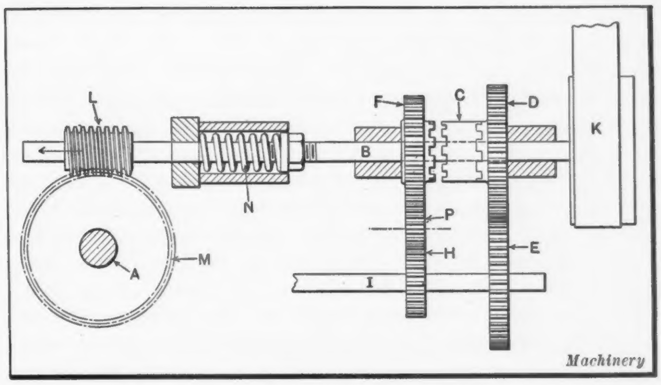


Fig. 23. Device for automatically stopping Feeding Motion when Resistance to Rotation becomes Excessive

velocity of the crank. As the return stroke begins, the velocity of the driven gear and crank gradually decreases, because the radius of the working side of the driving gear gradually diminishes; the result is that, when the crank is at right angles to the line along which the axis of pinion *C* moves and is in a position to impart the maximum velocity to pinion *C*, the speed of the crank is slowest, because it is then driven by the shortest radius of the driving gear. As the crank moves away from this central position at right angles to the center line of motion, the speed is gradually accelerated again, so that pinion *C* does not slow down as it would with a crank rotating at uniform speed. The reversal of the heavy press bed is assisted by means of air springs or cushions, the same as on cylinder presses in general. This mechanism is intended for small presses.

Crank Mechanism for Doubling Stroke

A crank and link mechanism is shown in Fig. 20 which makes it possible to obtain a rectilinear motion approximately equal to twice the throw of the driving crank. This mechanism is shown applied to an air pump for use on automobiles, either for the inflation of tires or in connection with engine starting apparatus requiring compressed air. The crank proper is of the center type with a bearing on each side. The connecting-rod is attached to the yoke *A*, which is mounted on the main crankpin. The opposite end of this yoke is pivoted to link *B*, which is suspended from a pin attached to the compressor casing. As the crankshaft rotates, this link oscillates and so controls the position of yoke *A* that the stroke of the piston is approximately doubled. The view to the left shows the piston at the lower end of its stroke. As the crank turns in a counterclockwise direction, link *B* swings to the right so that the right-hand end of yoke *A* is forced downward and the left-hand end upward, as indicated by the right-hand view, which shows the piston at the top of its stroke. The advantage of this crank mechanism is that it enables a comparatively large capacity to be obtained from a small, compact pump.

Planetary Gear and Crank Combination

The mechanism illustrated in Fig. 21 is applied to an electric coal-puncher. One of the difficulties encountered in designing coal-punchers, with the exception of the solenoid type, has been changing the rotation of the motor into a reciprocating motion for the drill. If the blow is directly dependent upon the motor, the latter causes trouble, owing to the vibrations and strains incident to the blows of the pick; and if springs are utilized, they are likely to break. Types having separate motors and flexible shaft connections have also been tried, but complications were introduced which at least partially offset the benefits derived.

The coal-puncher of which the mechanism shown in Fig. 21 forms a part uses both compressed air and electricity. Power for operating the coal-puncher is obtained from a motor and the compressed air gives the blow. There is no direct connection between the motor and striking pick, so that the vibrations are cushioned. The illustration shows the mechanical means by which the rotation of the motor armature is changed to a reciprocating motion for driving the air-compressing piston. A small pinion attached to the armature shaft engages a large driving gear (not shown) which has a solid web carrying the stud *d* upon which the crank pinion *e* is mounted. This crank pinion has thirty-three teeth and meshes with internal gear *f*, which is rigidly fastened to the frame of the machine and is concentric with the main driving gear which surrounds it. The pitch diameter of the crank pinion *e* is just one-half that of the internal gear *f*, which has sixty-six teeth. The crankpin *g* is attached to the pinion *e* and engages cross-head *h*, which is mounted in guides and receives a rectilinear motion as pinion *e* revolves around the internal gear. Attached to the cross-head, there is a piston-rod *a* which enters the air-compressing cylinder and has a piston secured to its forward end.

When the main driving gear is revolved by the motor, the crank pinion stud *d* describes a circular path, as indicated by the arrow, thus causing pinion *e* to revolve about the stud and around the internal gear. When stud *d* has moved one-quarter of a revolution, it will be in the position shown by the illustration to the right, and pin *g* attached to cross-head *h* will be in the center of the internal gear. At the completion of one-half a revolution, pin *g* will have moved in a straight line a distance equal to the pitch diameter of the internal gear, and will be at the right-hand end of its stroke. Similarly, at three-quarters of a revolution, the pin will again be in mid-position, and at the completion of a full revolution, it will be at the starting point, as shown by the view to the left. In this way, the crank pinion, as it revolves around the internal gear, transmits to pin *g* and the attached cross-head *h* a rectilinear forward and backward movement. The cross-head is mounted in guides, but pin *g* would follow a straight line even though guides were not used. This mechanism has the advantage of giving a long, gradually increasing and decreasing motion with a short crank and without the use of a connecting-rod or a slotted cross-head; therefore, it can be applied to some classes of mechanisms where there would not be sufficient room for a connecting-rod or in preference to the slotted yoke, because of mechanical objections to the latter. In designing this mechanism, the center of pin *g* should exactly coincide with the pitch circle of the internal gear; then, if the internal gear has twice as many teeth as the revolving gear, the center of *g* will move in a straight line, even though its motion is not constrained by means of guides.

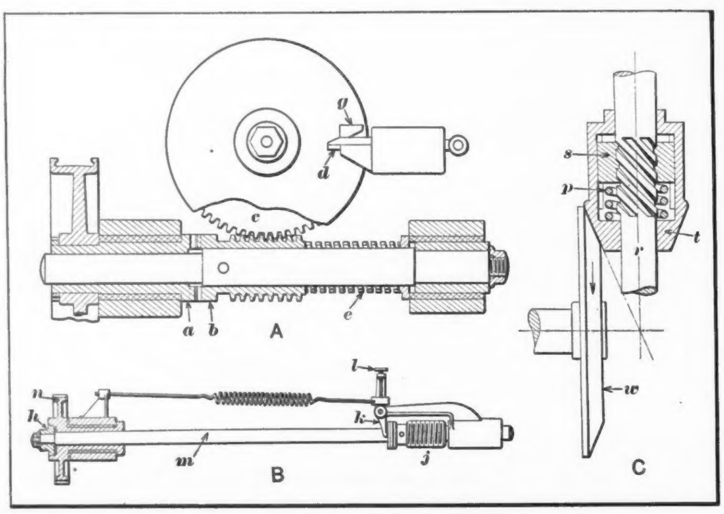


Fig. 24. (A) and (B) Devices for automatically disengaging Driven Member whenever Resistance to Motion increases excessively. (C) Friction Gearing designed to vary Contact Pressure According to Load

Reciprocating Motion from Planetary Gearing

What is known as a "wabble" gear is used on mowing machines for imparting a rapid reciprocating motion to the cutter-bar. The arrangement of this gearing and the other parts of the mechanism is shown in Fig. 22. The internal gear *C* is so mounted that it cannot rotate, but is free to oscillate on a universal gimbal joint *D*. The gear *B* which meshes with one side of *C* is mounted on the main shaft which connects with the driving wheels. The frame *J* is rigidly connected to gear *C* and is pivoted in the revolving part *H*. By this means, gear *C* is given an oscillating or wabbling movement, so that the entire gear describes or follows a circular path. This circular motion causes the teeth of gear *C* to mesh with those of gear *B* all around the circumference for each rotation of the part *H*. Part *H* turns on a fixed shaft *E* and acts somewhat as a fly-wheel to maintain steadiness of action, besides constraining gear *C* to follow a circular path.

In this case, gear *C* has forty-eight teeth, and gear *B*, forty-six teeth; therefore, if gear *B* were free to turn on its shaft, it would be displaced two teeth for each rotation of part *H* or each time gear *C* completed a circular movement. Consequently, twenty-three revolutions of part *H* and a like number of oscillations of frame *J* would be required to turn *B* one revolution. Tracing the motion in the opposite direction, it will be noted that one rotation of gear *B*, which acts as the driver when the mechanism is in operation, will cause twenty-three oscillations or wabbling movements of gear *C* and a like number of rotations of part *H*. The frame *J* is connected to the cutter-bar by the ball joint at *K*, so that one turn of the driving wheels which are mounted on shaft *A* will traverse the cutter-bar twenty-three times. This combination of gearing makes it possible to use a gear *B* having only two teeth less than the number in gear *C*, which would be practically impossible with gears having teeth parallel to the axis of the shaft. With the usual forms of planetary gearing, in which a high velocity ratio is obtained, the efficiency of transmission is low on account of the excessive tooth friction, but, in this case, the efficiency is said to be nearly as high as that obtained with a train of spur gears having the same velocity ratio.

Automatic Safeguards against Overload

Some types of machines are so arranged that any unusual resistance to motion will automatically stop either the entire machine or whatever part is affected, in order to prevent damaging the mechanism or straining it excessively. A simple form of safety device consists of a pin which shears off or breaks in case the overload becomes excessive. This method of protection against overload has been applied in various ways, and, while it is simple, there are certain disadvantages. In order to avoid replacing a broken pin, the machine operator sometimes inserts a pin that is stronger than it should be to afford adequate protection against injurious strains. The ideal safety device is one that does not break in case of overload, but simply disengages and is so arranged that it can readily be re-engaged. In electrical work, this principle has been applied by substituting circuit-breakers for fuses which melt when the current becomes excessive.

Automatic Clutch Control to Prevent Overload

The principle governing the operation of an automatic device for disengaging a clutch when the overload becomes excessive is illustrated by the diagram Fig. 23. This mechanism was applied to a metal-cutting machine, the object being to disengage the feed automatically in case the resistance to the rotation of the tool becomes abnormally high. The mechanism is also arranged to reverse the feeding movement if, for any reason, the excessive resistance should continue after the feed has been disengaged. The spindle to which the cutting tool is attached is represented at *A*. This spindle is driven through worm-wheel *M* and worm *L* from the driving shaft *B*, which receives its motion from a countershaft through a belt operating on pulley *K*. The driving shaft *B* is free to move in a lengthwise direction within certain limits. The clutch *C* is keyed to this shaft so that it will rotate and move axially with the shaft. The gears *D* and *F* on each side of clutch *C*

are free to revolve upon the shaft, but are prevented from moving in a lengthwise direction. The inner side of each gear is provided with clutch teeth corresponding to those on clutch *C*, which is used to lock either gear to shaft *B*. The shaft *I*, which transmits feeding movement to the cutting tool, is driven either through gears *D* and *E* or through gears *F*, *P*, and *H*. When clutch *C* engages gear *D*, the cutting tool is fed forward by shaft *I*, and a reversal of the feeding movement is obtained when clutch *C* is shifted into engagement with gear *F*.

When clutch *C* engages with gear *D*, excessive resistance to the motion of the cutting tool will cause the clutch to be shifted to the neutral position, thus stopping the feeding movement. This automatic action is obtained as follows: The shaft *B* is normally held by spring *N* in such a position that clutch *C* engages gear *D*, so that the feeding movement is forward. The tension on this spring is regulated by the nut shown. In case the resistance to the rotation of the cutting tool and spindle *A* should become excessive, the pressure between the teeth of the worm *L* and the worm-wheel *M* causes the worm to move in the direction indicated by the arrow, the worm-wheel acting somewhat like a nut. This lengthwise movement of the worm *L* and shaft *B*, against the tension of spring *N*, disengages clutch *C* from gear *D* and stops the feeding movement. If the resistance to rotation again becomes normal, clutch *C* is automatically returned into engagement with gear *D*. On the other hand, if the resistance to rotation increases, clutch *C* may be drawn over into engagement with gear *F*, thus reversing the feeding movement.

Other mechanical devices for automatically disengaging the driven member whenever the resistance to motion increases excessively are shown at *A* and *B* in Fig. 24. These devices operate on the same general principle as the one previously described, but differ somewhat in regard to the arrangement. The mechanism illustrated by diagram *A* is designed to allow a worm-wheel to make one revolution and then stop; the movement, however, may be discontinued before the revolution is completed, if the resistance to rotation becomes excessive. The sleeve *a* is revolved constantly by a pulley on its outer end. The inner end of this sleeve has clutch teeth intended to engage corresponding teeth on the end of sleeve *b*. The latter is attached to the shaft and both are free to move slightly in an endwise direction. The body of sleeve *b* is threaded to form a worm which engages worm-wheel *c*. The spring *e* tends to shift sleeve *b* to the left and into engagement with clutch teeth on sleeve *a*. The stop at *d* is utilized in this particular case to disengage the driving clutch after the worm-wheel has made one revolution. If stop *d* is withdrawn, spring *e* revolves the worm-wheel slightly and moves the worm and clutch *b* to the left and into engagement with the constantly revolving clutch *a*. The worm-wheel then begins to revolve and continues until the lug *g* strikes the stop *d* or until some unusual resistance too great to be overcome by the spring is encountered; then, as the worm-wheel remains stationary, it forms a nut for the worm which screws itself out of engagement with clutch *a*. The strength of spring *e* is proportioned with reference to the safe or maximum load to be transmitted. One of the advantages of this type of mechanism is that the motion is positively transmitted until an excessive load causes the driving clutch to be disengaged. Provision may readily be made for the adjustment of spring *e* so that the tension can be varied according to conditions.

Diagram *B*, Fig. 24, illustrates a modification of the same general type of mechanism. The shaft *m* is free to move slightly in an endwise direction and is keyed to the tapering disk *h*, which fits into a seat of corresponding taper in the hub of gear *n*, thus forming a friction clutch. Motion is applied to gear *n* and is transmitted by worm *j* to a worm-wheel (not shown), for any desired purpose. Shaft *m* turns freely in the hub of gear *n*, but is attached to worm *j*. The lever *k*, which has a spring fastened to it above the fulcrum or pivot, supplies the necessary amount of thrust to keep *h* in engagement with *n* under ordinary conditions. This thrust may be regulated by the thumb-screw *l*, which changes the position of the block to which the spring is fastened. If the resistance to the motion of the worm-wheel becomes excessive, the worm moves bodily along the teeth of the wheel, as though it were a nut, and, by moving shaft *m* and disk *h* to the left, disengages the friction clutch. The endwise thrust from lever *k* might be obtained by means of a weight instead of a spring.

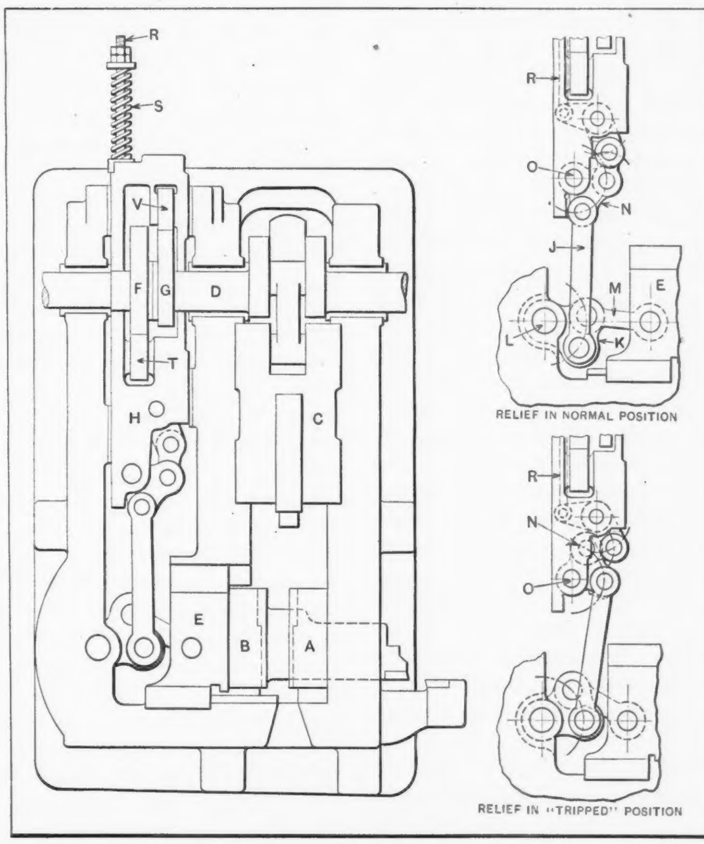


Fig. 25. Plan and Detail Views of Forging Machine showing Automatic Relief or Tripping Mechanism

Pressure of Friction Gearing Varied According to Load

A novel design of friction gearing, in which the pressure between the two friction wheels is automatically regulated by the amount of power transmitted, is shown at *C* in Fig. 24. The wheel *w*, which is the driver, revolves in the direction shown by the arrow. The driven pinion *t* is free either to rotate or slide in a lengthwise direction upon shaft *r* within certain limits. This shaft has a screw of coarse pitch which passes through nut *s*. This nut slides in grooves in the friction pinion *t* so that the pinion and nut revolve together. A spiral spring *p* inserted between nut *s* and the pinion forces the latter against the driver *w* with a pressure depending upon the position of the nut. If wheel *w* is revolving in the direction shown by the arrow and the driven shaft meets with an unusual degree of resistance to rotation, as soon as shaft *r* lags behind or stops revolving, nut *s* moves downward, owing to the action of the screw, and increases the compression on spring *p* and also the pressure between pinion *t* and wheel *w*. When the resistance to rotation again becomes normal, the spring moves the nut upward slightly and reduces the endwise thrust. While this device may not be entirely practicable, it embodies an interesting principle.

Automatic Relief Mechanisms for Forging Machines

Forging machines are equipped with a tripping or relief mechanism which prevents excessive straining or breakage of the parts controlling the motion of the movable die, in case the stock to be forged is not placed in the grooves of the dies but is caught between the flat faces. These relieving mechanisms differ somewhat in design, but the object in each case is to release the movable die, temporarily and automati-

cally, from the action of the driving mechanism, in case the operating parts are subjected to a strain or pressure that is abnormally high. The release may be obtained by inserting bolts or "breaker castings" in the mechanism, which will shear off or break if there is an excessive strain; another type of relief mechanism depends for its action upon a spring which is proportioned to resist compression for all ordinary strains but to compress sufficiently to release the pressure on the dies when that pressure increases beyond a safe maximum. Two forms of spring-controlled relief mechanisms will be described.

The plan view of a National forging machine, shown in Fig. 25, illustrates one method of arranging a spring and toggle relief mechanism. When this machine is in operation, the stock is gripped between the stationary die *A* and the movable die *B*. The heading slide *C*, which carries a ram or plunger for performing the forging operation, is actuated by a crank on the crankshaft *D*. The gripping slide *E* to which die *B* is attached is moved inward for gripping the stock and outward for releasing it, by means of two cams *F* and *G*. These cams transmit motion to slide *H*, which is connected with slide *E* through a toggle and link mechanism. Cam *F*, acting upon roll *T*, moves the slide *E* for gripping the stock, whereas cam *G*, in engagement with roll *V*, withdraws the die after the forging operation is completed. The upper detail view to the right shows the relief mechanism in its normal position, and the lower view shows it after being tripped to relieve any abnormal pressure on the dies.

When the machine is operating normally, link *J*, which connects with link *K* of the main gripping toggle, oscillates link *K* about pivot *L* and, through link *M*, imparts a reciprocating motion to the gripping slide *E*. If a piece of stock or some other part is caught between the flat die faces, the gripping action continues until the strain exceeds a certain amount; then the backward thrust upon link *N* causes it to swing about pivot *O* (see lower detailed view), carrying with it the other links of the by-pass toggle and compressing the spring *S*, which is shown in the plan view at the left. As the result of this change in the position of the by-pass toggle, pressure on the gripping die is released. Meanwhile the heading tool attached to slide *C* completes its full stroke and, upon the return stroke, the by-pass toggle is reset automatically by spring *S*, which expands and, through rod *R*, swings the toggle links back to their normal position shown in the upper detailed view. This automatic resetting of the toggle makes it unnecessary to stop the machine, which is necessary with safety devices of the breaking-bolt type. There is no movement of the by-pass toggle, except when a "sticker"—to use the shop expression—is caught between the gripping dies. While this relief mechanism safeguards the working parts from excessive strains, it is capable of transmitting enormous pressures to the gripping dies.

* * *

LOSS OF HEAT VALUE OF COAL IN STORAGE

According to investigations carried out by the Bureau of Mines, the expense of under-water storage equipment is not justified except as a preventive of fires from spontaneous combustion. In fact, the amount of deterioration of coal during storage has been commonly overestimated. While under-water storage of coal prevents deterioration of calorific value, in five years' storage in the open air Pittsburg coal deteriorated only about 1 per cent in one year, 2 per cent in two years, and from 2.5 to 3 per cent in five years. Pocahontas coal—a semi-bituminous type—lost less than 1 per cent of its heating value during two years of outdoor exposure. The Sheridan, Wyoming, sub-bituminous coal, known as "black lignite," lost 3 to 5.5 per cent of its heat value in two and three-fourths years of outdoor storage, the greater part of this loss being in the first nine months. The lumps became badly cracked so that they broke up on handling. By the use of bins with air-tight bottoms and sides and a protecting layer of fine slack, the loss in heat value in one year can be kept below 3 per cent and the physical deterioration will thus be largely prevented.

RESEARCH AND MANUFACTURING METHODS

BY COLE NEWMAN

A short time ago, the writer was asked to find all the possible methods of manufacturing, in large quantities, a rather complicated automobile accessory, consisting preferably of a single piece, so that the best method and material could be determined. At first he thought of collaborating with some person who might be designated by the name of "manufacturing engineer," but he found that no such person was accessible. Men who might be called by that title are usually specialists in some one method, more or less secret, and employed by some firm. He also found that manufacturing, as a science, does not appear to be taught in the technical schools. The few men who have a broad knowledge of the subject are executives of private firms and their services are not to be had, nor are they, as a rule, men of mechanical skill; their equipment consists of business knowledge only.

The writer then made a canvass of available methods and found that this piece could be manufactured, with slight modifications, by any of the following processes: die-casting, metal extrusion, die stamping, casting from bakelite, electrolysis, drop-forging, pressing from papier-mache, pressing in fiber, pressing in wood pulp, molding from amyl acetate in the form of celluloid, molding in rubber. However, no one man or organization could give information about these various processes together with their relative methods, costs and practicability. The different methods are in various stages of development; for instance, manufacture by electro-deposition is in the inventive stage, while some of the other methods are highly standardized. After investigating the various processes in use, an appeal to experts in physics and chemistry for suggestions in new processes and ideas opened up a more fertile field than the problem required. Since that time the writer has ventured to assume the initiative in thinking up possible new methods of manufacture for research and investigation.

During this canvass, the writer also became impressed with the need of courses, in the technical schools, that would give men a broad knowledge of manufacturing engineering. After the usual two years of training in mathematics and elementary engineering subjects, he would suggest a study of the action of materials when subjected to the various processes of manufacture and modern manufacturing methods, especially those on which the great industries of this country have been based. In the first two years would be included a thorough knowledge of materials and their behavior under all possible physical conditions and in all possible combinations, special attention being paid to the microscopic structure and the chemical formulas of the materials in question.

Many basic questions of manufacturing engineering await research and accurate technical solution; among these are the following: How does a cutting tool cut? Does the metal split ahead of it or is it crushed? Is the progress of the tool continuous or vibratory in nature? What is the action of cutting compounds and lubricants upon the tool and how do lubricants reach the edge of the tool, if they do reach it? To what extent can machine work be eliminated by die-casting? To what extent can castings and complicated structures be built up by electro-deposition? As electrically deposited metals are crystalline, can processes be developed for lengthening the crystals into fibers, as pig iron crystals are lengthened into tough fibrous wrought iron? How much pressure is required for causing various metals to flow under conditions of extrusion and hydraulic pressing processes? What qualities of metals require draft in dies? What qualities of metals require several dies to obtain a given extrusion? What qualities in metal permit of spinning? Can cheaper methods be devised for building dies? Given a certain object, what is the most satisfactory method of manufacturing a given number, investment and all other elements being considered? All these subjects have been discussed in the technical magazines and by the different engineering societies, but the manufacturing processes have not been coordinated as a science.

Loss to Industry through Lack of Manufacturing Engineers

When anyone proposes to take up a certain line of manufacturing activity, he tries to find a promising young man who will work with him for several years before a going factory is developed, because there is no such group of persons available as "manufacturing engineers." To be sure, there are factory experts, efficiency experts, etc., but these are usually men experienced in certain highly standardized methods of manufacturing, who refuse to conduct experiments or research along radical lines. Special processes, such as metal extrusion, making of steel cylinders, electrolytic deposits for the purpose of securing thin metal shavings, etc., have been developed by private firms or individuals who, for obvious reasons, will not permit them to come into general use. Each of these represents the result of high initiative and successful research.

What would be the result in this country if the physical, chemical and mechanical talent of our great universities were turned toward research in manufacturing processes? The writer ventures to look forward to a day when very intricate objects will be made by electrolytic deposits on paraffin patterns instead of our present cumbersome foundry methods. Then ships in a dry-dock will be plated electrolytically with pure copper instead of being painted by hand with a coating that can wear only a few months at best. He also looks forward to standardized ships, standardized docks, houses, streets, and everything else that requires fittings of metal or other material that can be in duplicate and standardized form.

There is something fundamental about the factory system of American industry that rises above the mere making of money and cheapening of the products; this is the lifting of the burden of manual labor from the individual. The average individual in the factory today works fewer hours and under vastly better conditions than the mechanic of fifty years ago. Where, at that time, could be found a shop that provided sanitary wash rooms, lockers, sunshine, recreation and a general cheerful atmosphere for its employes? Everything possible has been done to relieve the load of labor. The American system is to think a thing out once and then let the machine do it. Under the old system it had to be thought out every time the job was done.

All the material in this country is available for the manufacturing engineer, but it has not been assembled in the form of a definite profession. Reference books cover a large part of the field, but the processes that are less well-known or are still in the inventive stage have not been recognized seriously by those who conduct scientific researches. They have been left to inventors, whose educational and financial equipment may be insufficient. No work could be more worthy of government recognition and research than that of manufacturing processes.

When the average American graduates from a technical school, he thinks that the mechanical world consists entirely of turbines, gas engines and other prime movers waiting for his professional attention. When he enters the drafting-room or machine shop of an automobile, turbine, or electric motor factory, he is almost entirely blind to the relative importance of methods of manufacture. His thoughts unconsciously turn to the lines along which he has been trained to think, that is, the design of the automobile engine, or the steam turbine, or electric machinery, with little, if any, consideration for the vastly more important questions of how these things are to be manufactured in large quantities. What methods are to be employed? How many are to be made? What manufacturing machinery is available? What methods are available throughout the country? Where may the various parts be contracted for? What is the relative merit of each of these methods? Where can they be found? In what engineering form can they be put so as adequately to bring forward all the elements to be operated?

The practical business man secures the best results possible by the use of common sense; but the history of industry is that the use of "horse sense" has always been succeeded by careful analytical methods that eventually put horse sense and rule-of-thumb methods entirely out of the running. The blacksmith may laugh at the college man because he cannot shoe a horse properly nor swing a sledge hammer, but eventually the college man develops the automobile and the blacksmith goes out of existence for lack of a job.

Mechanical Effects Obtained by Men Who Know Metals

The writer at one time had the problem of manufacturing a nozzle for spraying, in which it was necessary to have a bored taper hole of excellent finish. No practical mechanic could make a fully satisfactory suggestion, owing to certain complications involved. A professor of physics suggested that the nozzle be made from a tube pulled in a testing machine until a certain reduction of area was obtained. The pieces could then be cut at the point of reduced area and nozzles of the desired taper obtained. This system was found to work perfectly. The pieces from the testing machine were put on a turret lathe, threaded, and cut at a reasonable total manufacturing cost. The professor knew nothing of manufacturing methods, but he knew materials and their physical characteristics.

The writer has made a number of tin flasks by simply clipping the edges of two disks together on a seaming machine, sealing them with solder, and then forcing water between the disks through a neck seamed onto one of them. The water pressure forced the disks apart, making an oblate bottle, which met the requirements. At another time, in Cleveland, the writer saw steel flasks capable of withstanding 2000 pounds pressure per square inch blown by hydraulic pressure, just as a glass bottle is blown in its mold by a glass blower. The steel bottle was blown by means of steam hydraulic compensating plungers, which multiplied pressure until from 15,000 to 20,000 pounds per square inch were momentarily obtained. On the Pacific Coast, a man makes an excellent living plating fruits, flowers and botanical specimens with copper. He has made careful researches in this line and conducts most of the work by methods known only to himself.

Now that the study of physical chemistry, with its more complete explanation of colloids and emulsions, is beginning to make clear the reasons for metal structure, and indeed for the structure of all materials, it seems propitious to inquire about the possibility of manufacturing research. It is being hinted by great investigators that transparency is the natural state of any pure substance; that is, if a substance is not transparent, it is a colloid, an emulsion, or both. The various organic substances, such as wood, paper, bone, hair, skin, leather, etc., are known to be dried emulsions, as it is possible to duplicate all of them entirely without the phenomena of life. This brings us very close to the possible manufacture of new materials, new substances besides our time-honored metal and wood.

The last twenty-five years has brought out only two or three important new substances for general industrial use. If research were directed along the lines suggested, who knows but that near equivalents for iron, steel, expensive hard woods and expensive building materials would be developed. Emulsion substitutes have been made, but they have not come into general use because of lack of research.

* * *

PRIZE OFFERED FOR HARDNESS-TESTING METHOD

Because of the difficulty of determining high hardness, that is, 580 Brinell hardness numeral and upward, where the material becomes so hard that it will scratch glass, Sir Robert Hadfield has given £200 (about $1000) to the Institution of Mechanical Engineers in London, England. This money, with any income therefrom, will be awarded as a prize for the description of a new accurate method of determining the hardness of metals. All or a part of it may be awarded at any time if a communication is received of sufficient originality and importance to accomplish the object sought; or, from time to time, parts of the fund, which do not exceed £75 in any year, for communications that seem to advance the knowledge of methods of testing hardness but do not completely solve the problem. Detailed information concerning this prize may be obtained from the Steel Treating Research Society, 762 Book Bldg., Detroit, Mich., of which Sir Robert Hadfield is a member.

INDICATOR GAGES USED IN GASOLINE-ENGINE CONSTRUCTION[1]

GAGES FOR INSPECTING CYLINDER DEPTH, LENGTH, EXTERNAL DIAMETER, CAM LIFT, PROFILE, AND ECCENTRICITY

BY C. C. MARSH[2]

WHILE many concerns strive to obtain a high degree of accuracy in production, they sometimes think that it is not necessary to maintain this accuracy in certain products because of the expensive inspection methods. Such tools as micrometers, vernier calipers, and hardness testing instruments, as well as various special recording and measuring devices, are costly, and the men required to do this work must be skilled mechanics, who, as a rule, must be paid more than toolmakers and machinists. Some manufacturers, however, have partly solved the problem of high inspection costs by designing and making special measuring tools by which ordinary mechanics will obtain a degree of accuracy close enough for their purpose.

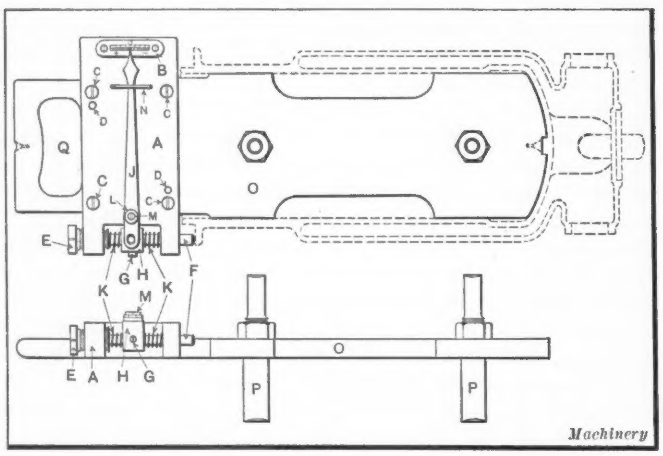


Fig. 1. Cylinder Depth Gage

Many lines of manufacturing require accuracy in machining combined with rapidity of production. Among these is gasoline-engine construction. Manufacturers of automobiles know that the inspection of machined parts on the engine requires more labor, a larger force of inspectors, and a greater number and variety of measuring tools and devices than the rest of the car. This is because the accuracy must be maintained on a greater proportion of the small parts on the engine than on the car. Yet there are many small concerns who do not hold the operator to a limit, except in such parts as actually have to be kept to some close measurement in order that they may fit and function properly.

Some machining fixtures may be so designed as to be nearly fool-proof, and also so as to produce accurate work when new, but after an operator who is doing piecework, and knows that his wages depend on the amount of work he turns out, uses a fixture a short time, the accuracy curve on that particular fixture begins to drop. As a result, there must be a new fixture and perhaps a new operator; also, the inaccurate parts must be scrapped or machined to "out sizes" so that they may be used. Either way is expensive. Still, many inspection operations on gasoline engines, although requiring much time on account of the inadequate measuring tools provided, do not give accurate results. These cases require measuring tools that can be used by an ordinary inspection-operator who can turn out a fair amount of work without misusing the tool. One type of gage for this kind of inspection is an indicator gage that may be adapted to many kinds of measurement.

It does not aid rapid production to give a machine operator a large, awkward gage to use; the simpler it is, the more likely is he to use it correctly. The operator's accuracy on production depends not only on having accurate and easily operated machine tools and fixtures and on his skill in operating these, but also on having gages that he can use quickly and that will gage accurately. Although the indicator gage is better adapted for inspection uses where rapid operations are required, it is possible to adapt it to the operator's use. Where large diameters are turned, holes bored, and shoulders faced, indicator gages of the types shown in Figs. 1, 3, and 4 are satisfactory.

While all of these types of indicator gages may be successfully designed and used, indicator gages should not be used for gaging internal diameters. Measuring an internal diameter accurately is a more delicate operation than measuring external diameters and lengths; therefore, a gage of this design is too heavy, and is hard to revolve so as to determine whether or not a hole is out of round. Besides, the plunger-pin would have to work so that it would be certain to rest against the side of the hole in such a manner that its longitudinal center would coincide with the axial center of the hole. This might be done, but provision would have to be made so that the error in the size of the hole would not affect the plunger-pin in such a way as to cause the hand to indicate the error from one side instead of both sides of the hole.

Even with the accurate machine tool equipment that is now procurable, accuracy in production cannot be obtained without constant care in gaging and measuring. Few machine tools retain their accuracy after they have been used for a time; even those that are very heavy and rigidly built cannot maintain their accuracy under constant wear and the strain of rapid production. The same conditions prevail in regard to measuring tools, which should, therefore, be made simple and should have some means of adjustment to compensate for wear. Although adjustment may not be practicable in all cases, it will result in a great saving of time in production as well as the time necessary to replace the tool.

Indicator Gage for Cylinder Depth

The gage shown in Fig. 1 does not require much accurate tool work in making, yet, if properly made, it gages accurately and quickly. A sectional view of the assembled plunger-pin plate *A* is shown in Fig. 2. An indicator gage, of course, multiplies the error, the degree of multiplication depending on the depth of the hole and the length of the gage. The latter must be approximately determined, together with the ratio between the long and the short end of the indicator hand, before designing the tool. When this ratio is decided upon, it is necessary to find the distance between the graduation lines.

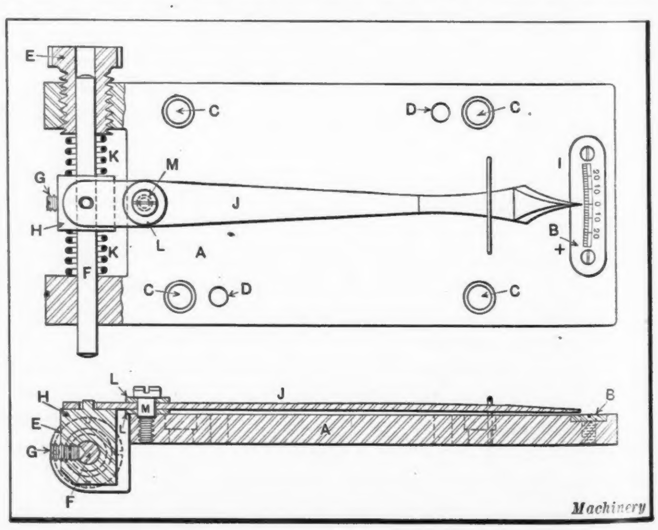


Fig. 2. Plunger Indicator and Plate of Gage shown in Fig. 1

In the case shown, the drawing of the cylinder called for a bored depth of the barrel of 13 1/16 inches ± 0.005 inch. It will be noted that the graduated plate *B* at the end of the plunger-pin plate *A* is marked + on the left-hand and — on the right-hand side of the zero mark, under the graduations. The ratio of the long end to the short end of the indicator

[1] For other articles on indicating gages, see "Profile and Indicating Gages," November and December, 1916, and articles there referred to.
[2] Address: 1338 Barth Ave., Indianapolis, Ind.

hand J, measuring from the pivot screw M, is 7.8125 to 1. Thus, when the plunger-pin F moves 0.002 inch, the point of the indicator hand J will move 1/64 inch. Then the graduated lines must be scribed 0.015625 inch apart at the end of the hand J, and radiating outward from the center of the pivot screw M.

This plate can be accurately graduated on a dividing head by computing the circumference of a circle having a diameter equal to twice the length of the long end of the indicator hand and dividing this by the distance required between the graduations. This will give the number of divisions required on the dividing head, from which the necessary number of turns of the dividing head can be determined. The following formula may be used for this:

$$N = \frac{2\pi L}{D}$$

in which L = length of long end of lever;
D = distance between graduations;
N = number of divisions in circle.

In the case of the gage shown, where the length L of the long end of the lever is 7.8125 inches, the number of divisions N on a circle 15.625 inches in diameter, when the distance D between the graduations is 0.015625 inch, is:

$$\frac{2 \times 3.1416 \times 7.8125}{0.015625} = 3141.6$$

The figure 3141.6 is so near 3142 that on so many divisions the 0.4 difference will make so slight an error as to be practically of no consequence; therefore, it is quite safe to use the latter figure as the proper number of divisions.

The graduated plate B can be made of ordinary machine steel and left soft, although both sides should be surface-ground before graduating. It fits in a recess milled in the plunger-pin plate A and is fastened in place by two flat-head screws. It should fit this recess without play so that the center line passing through the zero mark is coincident with the center line of the indicator hand.

The plunger-pin plate can also be made of ordinary machine steel, and is held in position on the gage-plate by four fillister-head screws C. Two pins D keep it from slipping and allow it to be replaced in the same position should it be taken off at any time. The plunger-pin holes should be bored in line

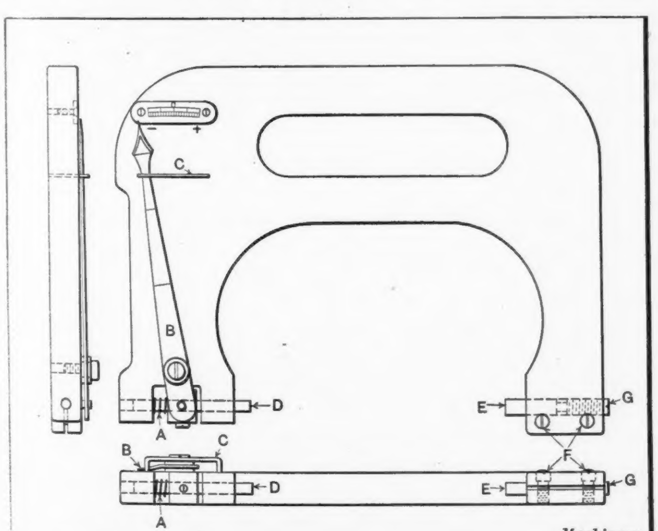


Fig. 3. External Diameter Gage

and one hole tapped for the screw bushing E that adjusts the tension of the compensating springs. The plunger-pin F should be made of drill rod or tool steel and hardened on the engaging end. It should be left soft in the middle where the lock-screw G holds it in the block H that actuates the hand J. The latter should be made of spring steel and should be at least 1/16 inch thick. Its point should be tapered and sharpened so that it will point between the graduated lines. The springs K are made of music wire; the one on the bushing side should be a little stronger than the other, so that the adjusting bushing E may be screwed back and forth until the hand J rests in the proper position when adjusting the gage. The plunger-pin F should be round on the engaging end, so that it will touch only on one point, which should be the longitudinal center of the pin.

The block H on the plunger-pin F that actuates the indicator hand J should be made of tool steel, and the round shoulder that fits into the hand J should be turned to fit the hole in the latter with not over 0.0005 inch play. The amount of this play should be known and kept in mind so that allowance may be made in reading measurements made with this gage. This shoulder should be polished so that it will work freely, yet without too great an error. Hardened washers L with sides

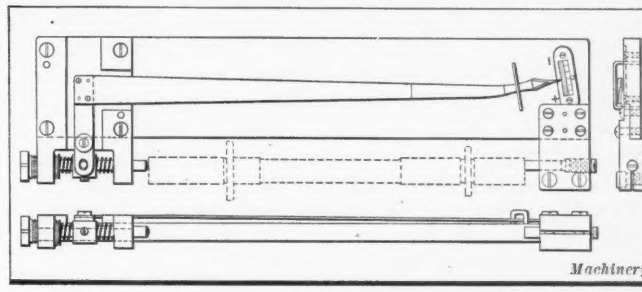


Fig. 4. Adjustable Length Gage

ground true should be placed above and below the indicator hand where the pivot screw M passes through; these act as guides to the indicator hand and prevent any vertical movement. The pivot screw M should have an accurately turned, polished, and hardened section under the head on which the indicator hand J swings. The shoulder of this screw rests firmly against the plunger-pin plate A and should be about 0.003 inch longer than the combined thickness of the indicator hand and the two washers, so as to allow free movement of the hand on the screw. A piece N of No. 30 drill rod, bent in the shape of a staple, is pressed into holes in the plunger-pin plate to keep the hand from being bent by accident. A sheet-metal guard may be provided, if desired, to completely cover the indicator hand up to the graduated plate; this can be held in place by round-head screws.

The gage-plate O, Fig. 1, is made of machine steel, and the end that fits the bottom of the hole, as well as the sides, should be carburized, the edges relieved, and two holes drilled through it on the longitudinal center to receive the two studs P that keep the plate central in the hole while in use. These studs are made of cold-rolled steel and carburized, and a small amount of stock is left on the ends so that, after fitting to the plate and after the latter is centered, the plate and the studs together can be turned on a lathe. The carburizing should be deep enough so that all of the carburized surface will not be turned off in the lathe. About 1/64 inch is enough to remove, and 0.01 inch should be left on the ends of the pins and the edges of the plate for grinding after the plate is hardened. This work must be done before fitting the plunger-pin plate. The centering pins P have a shoulder, which rests on one side of the gage-plate, and as these pins are threaded, they may be held very firmly with the nuts as shown. When grinding the gage-plate on centers, it must be borne in mind that the plate must easily enter the hole in which it is to be used so that proper allowance will be made for this. By cutting the oblong hole Q in the other end of the plate, a convenient handle is formed for the gage.

Adjustable Length and External Diameter Gages

The gages shown in Figs. 3 and 4 are an adaptation of the same principle, with such changes in design as are needed for the difference in purpose. The gage shown in Fig. 3 has only one plunger-pin spring A, in order that the hand B may be pushed over as far as the guard C will allow. This gage does not require a very strong spring, and the plunger-pin D should always protrude from the gage, as shown. Another feature of this gage is the adjustable anvil E, which is a hardened pin and is held in place by two screws F. By having pins of different lengths, it is possible to give the gage

quite a wide range of use. A set-screw *G* makes the adjustment of the anvil easy. The setting of this gage is quite simple, the only tools necessary being a thin piece of metal to slip under the indicating hand, a small clamp, a screwdriver, and a micrometer for measuring inside diameters. The metal shim is placed under the indicator hand and the clamp is used to hold the hand in the middle position. After the micrometer has been set, the anvil *E* is placed in position and the clamping screws *F* tightened slightly; then the anvil is adjusted to the micrometer by means of the adjusting screws *G* and the clamping screws *F* are tightened. When the clamp and shim are removed, the gage is ready for use.

In using this type of gage, the distance between the anvil and the plunger-pin must be enough less than the lowest limit of the length or diameter that the gage is to measure so that, when the part measured is of the correct dimension called for on the drawing of the part on which the gage is to be used, the indicator hand points to zero. That is, this dimension must be between the upper and the lower limits that are specified. The exact dimension is zero; the left-hand side of the graduated plate is the minus side and the right-hand side is the plus side. The hand will indicate whether the dimension is less or greater and how much. The graduating is done in the same manner as on the cylinder depth gage.

As the gage shown in Fig. 4 is for longer measurements, it is made of more pieces for ease and economy in construction. Two springs are provided, as on the cylinder depth gage, on account of the length of the indicator hand; these serve to keep the hand steadier, but both are not entirely necessary. The indicator hand has a slight bend at the outer end, so that the point will move in a direct radial arc from the center of the pivot screw. The length of the long end of the indicator hand in this gage is taken to be the shortest distance between the end of the hand and the center of the pivot screw. The hand is made in two pieces, which are fastened together with round-head screws, while two dowel-pins are used to prevent play in the screws, the hand moving in recesses milled in the plunger-pin plate. In order that the gage will not be too thick, the plunger-pin and anvil plates are fitted to the long plate that forms the body of the gage with mortised joints. This construction will insure that the plunger and anvil pins do not come above or below the sides of the long plate. The leverage of the indicator hand can be in much greater proportion than in the gages already shown; consequently the graduations can be farther apart, though they can represent smaller figures in relation to the plunger-pin, thus making this gage read closer. The adjustment of the anvil pin is accomplished in the same way as the one on the gage shown in Fig. 3; this pin also can be replaced by others of varying lengths. Both pins should be rounded slightly on the engaging ends. A sheet-metal cover may be provided instead of the wire guard to cover the indicator hand, if desired. This gage may be constructed so that it will reach over quite wide shoulders on various parts that require close dimensions.

Cam Lift, Profile, and Eccentricity Gage

A three-purpose gage intended for use on camshafts, but which may be adapted to other similar uses, is shown in Fig. 5. The first purpose of this gage is to determine whether or not the cams, which are generally integral with the shaft, have the proper lift and fall, so that the valves may be opened and closed the proper distance and in the proper time; the second purpose is to determine if the profile is correct all the way around the cam, so that the valves will have a uniform action; the third purpose is to determine if the cams are at the proper angles to one another and whether they are concentric to the center of the shaft. The last fact must be known if a quiet-running motor is desired. This gage consists of a cast-iron base *A* with a cast bracket *B* at each end. It is machined on the top and bottom, and its size depends on the length of the camshaft. The brackets support the camshaft when it is placed in the bearings, which are bored to fit the journals at each end of the shaft. The caps *C* on these bearings are pivoted on pins *D* in the manner of a hinge, so that the shaft may be quickly placed in the bearings. Eyebolts *E* that swing on a pin *F* in a similar manner and are fitted with wing-nuts *G* are used to tighten the caps.

A large circular plate *H* is graduated, in degrees, completely around its outer edge and is counterbored on the opposite side of the graduations to fit closely the gear flange on the end of the camshaft. Two dowel-pins in this plate fit into two drilled holes in the gear flange. As these holes are spaced so that the gear can only be placed on the flange in one position, this flange will fit the graduated plate in the same position each time. The holes are drilled in the gear flange in an accurate jig; therefore, they are quite likely to be uniform as to spacing and diameter. A small screw *J* with a countersunk head that fits the countersink in the drilled holes is placed in the gear flange before the shaft is placed in the fixture and is passed through the graduated plate *H*; it is then fastened in place by a small wing-nut *K*. The end of a small pointer *L* fastened by two round-head screws to the base *A* shows the angle through which the plate and camshaft are turned. The point of this indicator is tangent to the perpendicular center of the fixture.

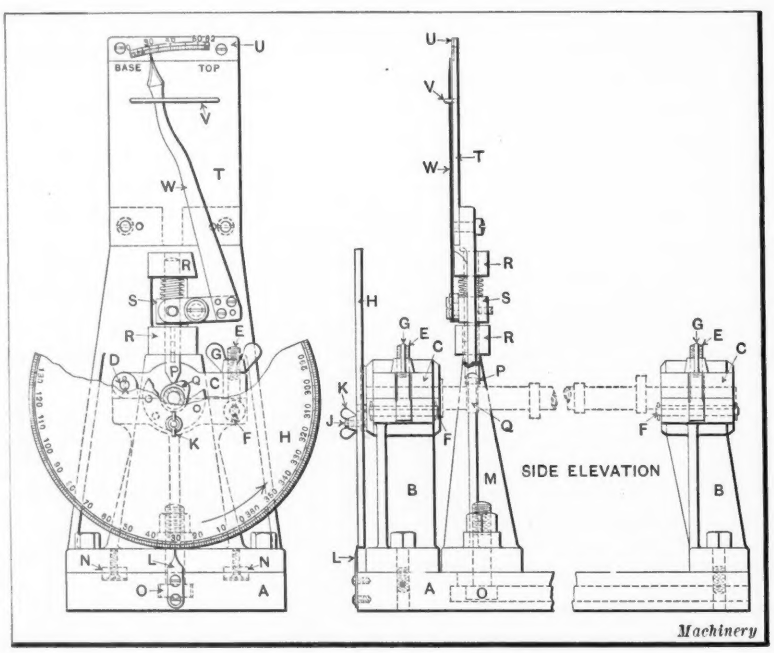


Fig. 5. Cam Lift, Profile, and Eccentricity Gage

The gaging part of the fixture, which is separate and detachable, is a casting *M* with a base in which are two steel tongues *N* that fit into grooves planed into the base *A*. The gage, therefore, can be slid along on the base *A* and yet retain its lateral position. A T-bolt *O*, the head of which slides easily in a slot in base *A*, allows the gaging device to be locked firmly over any one cam by the use of a wrench that fits the nut on the bolt; this allows the plunger-pin *P* to come into the correct position over the cam *Q*. The plunger-pin works in a vertical direction through two bosses *R*, which are a part of casting *M*. These two holes should fit the pin without play and should be bored and line-reamed at right angles to the machined base. The bosses may be fitted with hardened bushings, although these are not necessary unless the gage is to be used a great deal. A similar block *S* is fastened to the plunger-pin *P* by a lock-screw for actuating the indicator hand *W*, which is similar to that on the gages previously described. On account of the position of the plunger-pin, it is necessary to have a bend in the indicator hand *W*, while the bosses *R* make it necessary to have a slight curve in the upper end of the hand so that the end of the hand will line up with the center of the pivot screw and swing in an arc that will be nearly divided on equal sides of the perpendicular center line of the machine-steel plate *T* that is bolted to the casting *M*.

The graduations on the plate U must equal the rise per degree, or other required division of the cam periphery, and must radiate from the center of the pivot screw. It will be noted that the word "base" is stamped on the left-hand end of the plate, while on the right-hand end the word "top" appears. The arrow on the circular plate H shows in which direction the shaft and plates are to be rotated. A wire guard V on the upper part of the gage allows the hand to swing far enough past the last graduated line on the plate U to show any error on the base circle of the cam or the rounded part that is concentric with the shaft.

When the fixture M is placed in the correct position for testing a cam, the plunger-pin P rests on the base circle at the point of tangency to the line forming the beginning of the rise or opening point on the periphery of the cam. The pointer L on the base A now points to zero on the circular plate H, or the beginning of rotation, and the indicator hand W should point to the first line on the graduated plate U, which is also marked zero. As plate H is rotated, indicator hand W shows the acceleration of the rise on the cam. Suppose the cam is intended to rise for, say, 62 degrees of the rotation of the shaft; if the periphery is correct, pointer L on base A shows when that point in the travel of the cam is reached, and the travel of indicator hand W will coincide with it until the total rise is reached. If the rise is incorrect, because the cam has either a convex or a concave surface, indicator hand W will not be in synchronism with pointer L and there will be an incorrect opening action of the valve. If the cam does not have the proper radius on the top of the rise, the hand will not agree with the pointer.

The fact that a cam may have a convex or a concave surface may not affect the opening, especially if the cam is designed to use a mushroom follower or to use a roller and to be what is known as a constant-acceleration cam. Cams using a mushroom follower have a convex flank, while a constant-acceleration cam has a concave flank. The kind having a straight flank, and called a tangential cam, would show the error more to advantage. This does not mean that inaccuracies on the flanks of the two former types could not be detected with this form of gage; but the actual rise may vary slightly on the two former types without causing serious error in the action of the valve, the main thing being that the cam must raise the valve the correct distance in the proper time, which, of course, must be in the proper angle of rotation of the shaft.

As the shaft is rotated, if the cam is supposed to be symmetrical on either flank, after the top of the cam is reached, the fall will be the reverse of the rise and the indicator hand will retrace its swing and arrive at the zero mark on the inserted plate at precisely the same moment that the pointer L has reached 124 degrees on the plate H. By means of the graduations on plate U, it is possible to find any incorrect spot on the flank. If the cam is designed so that it has a rest at the top of the rise, the indicator hand will remain stationary, as the periphery is concentric. The same thing will occur with the hand when the end of the fall, or the closing side of the cam, is reached and the plunger-pin rests on the base circle of the cam. Unless the base circle is concentric with the shaft, the indicator hand will show movement when the shaft is rotated through the remaining part of the 360 degrees as indicated by the pointer.

The plunger-pin P is a round pin flattened on two sides, or tapered so that a small curve can be machined on the engaging end. The flattened sides should always remain at 90 degrees to the profile line of rotation of the cam, so that the pin will always present a rounded end to the periphery of the cam and act the same as the face of a small roller. As most of the imperfections on the cam faces are depressions or humps, which are, as a rule, simply tool marks, the pin should be set so that it drops into or is raised by them, as the case may be. These marks usually run clear across the face of the cam; those that do not probably will not affect the action of the roller used on the cam. The small curve on the end of the pin will act better than a roller, as the latter must be large enough to have a pin through it to turn on. The arc of contact is less for a small curve than for a roller; therefore, the pin will show a smaller error. A small key should be fastened in the lower pin boss and a keyway provided in the pin to allow the pin to move up and down, though it is prevented from turning.

Now, suppose it is necessary to find out if the next cam of the same set, say the intake side, is supposed to be in a position of 90 degrees to the first cam, rotating counterclockwise. The locking nut on the T-bolt O is loosened, the gaging fixture M then being slid along to the position over the second cam. The plunger-pin P is then raised by pushing over the indicator hand W with the finger, and the lock-nut is tightened again on the T-bolt. The camshaft is left in the same position, or on the point of rise of the first cam, the pointer being at zero. After the gage is locked in place, the indicator hand W is allowed to rest on the periphery of the second cam. If the second cam is correct, the indicator hand will register the top of the rise while the pointer L registers 152 degrees. Thus it is possible to find the relative position of angles and the opening, closing, and rest points of all cams of that set. It is necessary, however, to have a separate gaging device to fit on the base for the cams of the other set, that is, one for the intake and one for the exhaust cams.

It is seldom necessary to gage all the cams on all shafts. There are always a few faulty cams, however, that pass the inspector who uses some other kind of measuring instrument than the indicator gage. When these cams are assembled into motors they may cause erratic running of the engine on the block-test, in which case, when the engine is being torn down after the block-test, the camshafts may be removed for inspection on this fixture.

There is an apparatus that records the outline of the periphery of the cams by means of electric contact, using an indicator hand that traces a curve on a geometrically ruled chart. This instrument records the profile curve of all the cams on the shaft in one revolution. While this is quite a feature, the instrument is expensive and is necessarily delicate and must be used by skilled operators. It is also more likely to be affected by temperature, while the gage here described may be used in almost any place where there is room on a bench or a table.

The graduating on the inserted plate on the former gage can easily be done by using a master cam, or one that is known to be correct. After the circular plate has been graduated in degrees and the dowel-pins placed in the correct position, the plate is placed on a shaft with a master cam fastened on in the proper position and the disk rotated with the shaft by degrees, or greater divisions, while the point of the indicator hand shows where the lines should be scribed; this must be done after fastening the inserted plate in place.

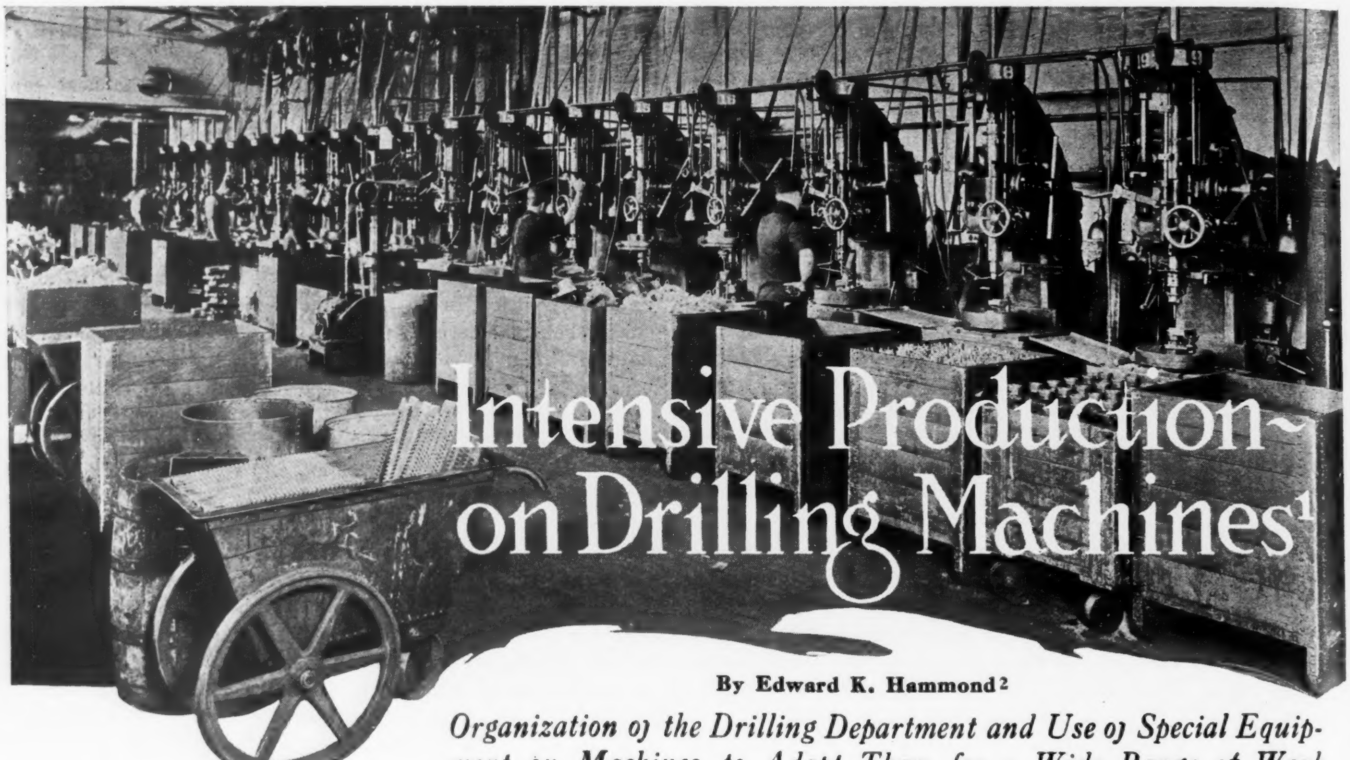
There is no doubt that the indicator gage will find a more general use and can well be adapted for other uses than gasoline-engine construction. Some of the various purposes may make some change in design and necessary improvements that will probably cause it to become a popular tool.

* * *

"It is generally believed that I built the Panama Canal," said Major-General George W. Goethals at the meeting of the American Society of Mechanical Engineers, when honorary membership in the society was conferred upon him. "That is a mistake. I claim to have been one of fifty thousand men who built it. I learned exactly where I came in, in a trip that I took across the canal in a Panama railroad train, when the foreman, describing the canal to a visitor, led the visitor to understand that he was doing pretty much all of it. The visitor finally turned to him and said: 'What is the "Old Man," as you call him, doing?' The foreman replied: 'Oh, he comes around and sees us doing it, jollies us a bit, and then goes back and sits in the office and entertains visitors.'"

* * *

The French military authorities claim that their famous 75's owe their longevity to the fact that the steel liner contains molybdenum, which increases the life about twenty times. It has been found that tungsten-lined guns crystallize, after a certain number of shots have been fired, and are rendered practically useless, whereas molybdenum-lined guns seem to last indefinitely.



Intensive Production—on Drilling Machines[1]

By Edward K. Hammond[2]

Organization of the Drilling Department and Use of Special Equipment on Machines to Adapt Them for a Wide Range of Work

THERE are many shop superintendents and men in charge of the planning of machining operations who do not realize the full scope of work which may be efficiently handled on drilling machines. In many shops gratifying results are obtained in the performance of such operations as drilling, counterboring, reaming, and tapping; but most factory executives have a well defined idea of what constitutes "drill press work," and the use which they make of their drilling machines is confined to those pieces which come under this arbitrary classification. Those in charge of the machine shops in some progressive manufacturing plants have recently broken away from this idea and have extended the use of drilling machines to provide for handling many operations for which turret lathes, engine lathes and other types of machine tools were formerly employed. In so doing the quality of workmanship has been kept up to the previous standards and in practically every case rates of production have been materially increased. There are few shops where a wider range of manufacturing operations are handled on heavy-duty drilling machines or where higher rates of production are obtained on this type of machine than at the plant of S. F. Bowser & Co., Inc., Fort Wayne, Ind. This concern operates a battery of twenty-eight of the No. 310 high-duty drilling machines built by Baker Bros., Toledo, Ohio, and the organization of systems for the expeditious handling of work and the development of jigs, fixtures and special cutting tools for use on these machines has been carried to a high degree of perfection by Sherwood Hinds, factory engineer of the Bowser Co.

Many shop men who have formed their own opinions as to what constitutes the range of work that can be efficiently handled on drilling machines would be greatly surprised at the results which Mr. Hinds is obtaining in the Bowser shops. Two points would doubtless be the first to attract attention, namely, the great variety of machining operations that are performed, and the extremely high rates of production which are secured with a relatively small labor cost for the operation of machines. In addition to the familiar operations of drilling, counterboring, reaming, tapping, etc., a variety of other operations, including turning, threading, facing and boring, are performed under conditions that give very satisfactory results from the standpoints of finish, accuracy and rates of production. There are necessarily a number of details concerning the operation of this department which vary according to the character of the work, but the basic principles governing the handling of all classes of work are as follows: The machines are set up in one row and placed close enough together so that sheet metal troughs extend from table to table of adjacent machines. As a result, when the operation on one machine has been completed, the work may be pushed across to the next machine with a minimum expenditure of time and exertion on the part of the operator. The parallel between this plan and the operation of turret lathes for handling the same work will be obvious. Instead of indexing a turret to bring successive tools into operation, the work is moved along under the spindles of machines carrying the required tools. Operations are conducted on the progressive system, but although many parts are handled which require a considerable number of operations to complete them ready for the assembling department—running as high as twelve operations in some cases—it is never found advisable to have so many machines working on the same piece at one time.

Before giving the subject serious consideration it would doubtless appear that the most efficient results would be obtained by setting up a sufficient number of machines to enable the work to be completed without the necessity of intermediate handling between the performance of different series of operations. Experience has shown, however, that on the average classes of work handled on these machines, one operator is able to take care of four machines. Accepting this as a basis of operation, and considering the case of a piece in which twelve operations are required to finish the machining, it at once becomes apparent that three operators and three groups of four machines would be necessary. So long as there is no interruption in the process of manufacture, the greatest efficiency would result through setting up twelve machines so that the work could be handed along progressively until the last operation was completed, after which the pieces would be transferred to the painting department preparatory to being assembled. As a matter of fact, the method of procedure would probably be to handle the first four operations as if their completion resulted in finishing the work: this set of four machines would then be dismantled and set up for the second set of four operations, and after these operations had been completed, the machines would again be dismantled and set up for the final operations. The reason for adopting this method is that experience has shown that where more than four machines are operated at a time, delays resulting from the breakage of tools on any one machine or the tempor-

[1] For information on drilling practice previously published in MACHINERY, see "Drill Grinding," in the May number.
[2] Associate Editor of MACHINERY.

ary absence of one operator from his group of machines would result in a congestion of work and delay of one or more of the other operators, which would far more than offset the time saved by the avoidance of what might appear to be two unnecessary transfers of the work from machines to trucks, and vice versa. Another advantage of subdividing the total series of machining operations in this way is that the percentage of the total machine equipment used on a single piece at any one time is greatly reduced. As there are a large number of different parts constantly going through the shop, it would be poor practice to tie up as many as twelve machines out of twenty-eight on a single job.

No difficulty has been experienced in using four machines for a piece, regardless of the number of operations. Pieces with one operation would have four sets of tools and fixtures; pieces with two operations would have two sets of tools; and pieces with six or ten operations would have the tools doubled for the last two operations, which would enable the operator to do the last two operations on four machines, finishing two pieces at a time. With pieces requiring three, five, seven, or nine operations, etc., it is usually possible to combine two of the operations so as to fit an even number of machines, or else, in cases where there is one long operation, to set up two machines for this, the operator having time to perform the other two operations of this group on two pieces while either of the first two machines is performing one operation. An example of nine operations being performed on eight machines is shown on piece No. 15 of the listed parts; an example of a piece with three operations being performed to advantage on four machines is shown on part No. 2; and an example of a piece with five operations being performed on four machines is shown on part No. 4. The detailed method of operations on this piece is as follows:

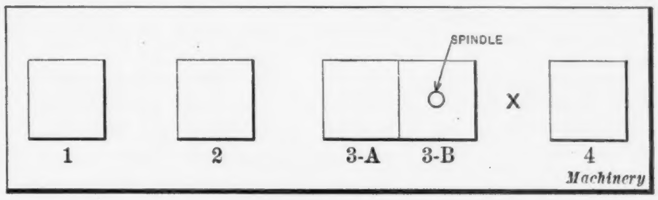


Fig. 1. Diagram illustrating Procedure in moving Work from Machine to Machine to keep All Machines in Group constantly in Operation

Referring to Fig. 1, it will be seen that four machines are used, the boring operation being performed on the first, turning on the second, tapping on the third, and threading on the fourth. The third operation is really a double one, because the piece is tapped with a taper pipe tap from each side. The machine for this operation has a sliding fixture with provisions for holding two pieces, one of these being inverted. The order followed by the operator of this group of machines in going about his work is as follows: (1) Remove bored piece from machine No. 1 and set up fresh blank. (2) Remove turned piece from machine No. 2 and set up bored piece from machine No. 1. (3) Remove piece from 3-B and place in position marked by a cross between 3-B and 4 in Fig. 1; remove piece from 3-A and place in position 3-B; take bored and turned piece from machine No. 2 and place in position 3-A; slide fixture until spindle is over 3-A and start machine No. 3. (4) Remove finished piece from machine No. 4 and set up piece which was set in position marked by cross between machines Nos. 3 and 4. (5) Go back to machine No. 3, hole at 3-A being tapped by this time, push fixture over and start spindle in piece in position 3-B. (6) Return to machine No. 1.

Another point which helps out the machining of pieces where it is necessary to perform a number of operations is the possibility of using portable machines, such as tappers, etc., to take a fifth and seventh operation. Piece No. 11 in the List of Parts, Order of Machining Operations and Rates of Production is an example of this. With such highly systematized methods for the performance of a sequence of opera-

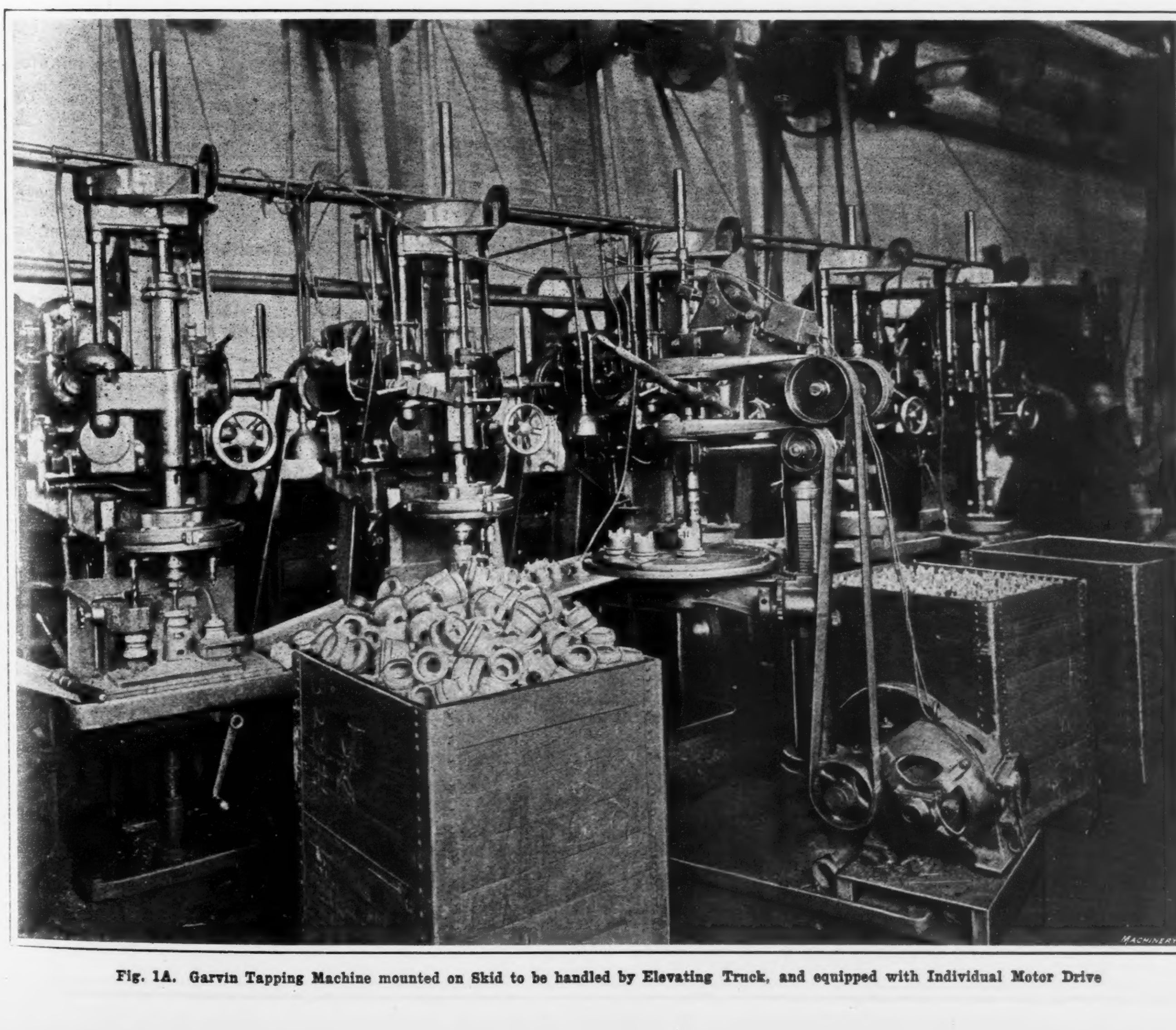
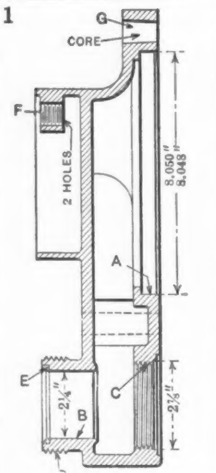
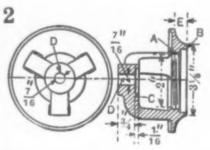
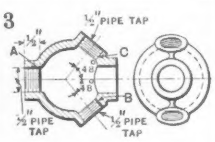
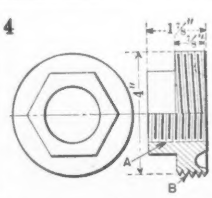
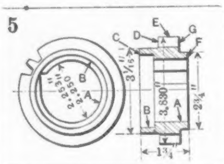
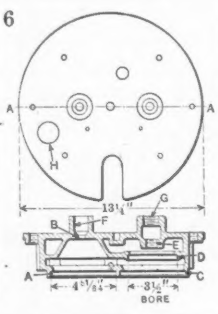
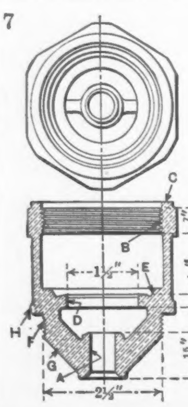


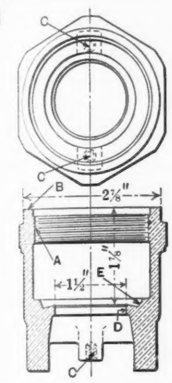
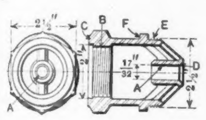
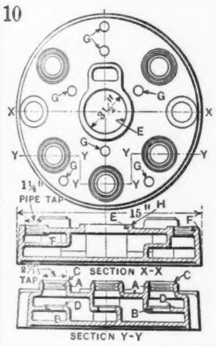
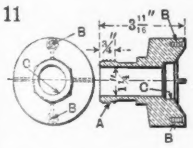
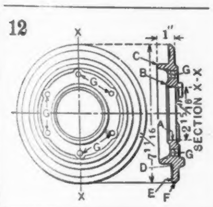
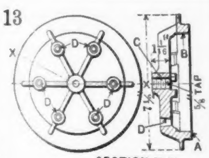
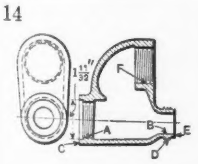
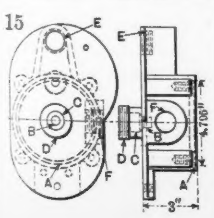
Fig. 1A. Garvin Tapping Machine mounted on Skid to be handled by Elevating Truck, and equipped with Individual Motor Drive

LIST OF PARTS, ORDER OF MACHINING OPERATIONS AND RATES OF PRODUCTION

	Oper. No.	Operation	Notes on Special Features of Tool Equipment	Material Production Time
1 	1	Grind top and bottom of work.	Besly double disk grinder.	Cast iron. 13 minutes.
	2	Bore hole *A*.	See Figs. 12 and 13.	
	3	Ream hole *A*.	See Figs. 12 and 14.	
	4	Rough-bore holes *B* and *C*, and chamfer top of hole *B*.	See Figs. 12 and 16.	
	5	Finish-bore and face top of hole *B*, counterbore and face top of hole *C*.	See Figs. 15 and 17.	
	6	Tap hole *C*.	See Figs. 12 and 18.	
	7	Finish valve seat at top of hole *B*.	See Fig. 19.	
	8	Turn and face top of union *D*, bore seat for bronze bushing *E*.	See Figs. 20 and 21.	
	9	Ream seat for bushing *E*.	See Figs. 20 and 22.	
	10	Thread union *D*.	See Fig. 20.	
	11	Press in bushing *E*.	Portable arbor press.	
	12	Chamfer bushing *E*.	See Figs. 20 and 23.	
	13	Drill two holes *F*.	See Figs. 20 and 24.	
	14	Tap two holes *F*.	See Fig. 20.	
2 	1	Bore hole *A*, face flange *B* and counterbore at *C*.	Combination boring, counterboring and facing tool with provision for holding dimension *E*.	Cast iron. 1 minute.
	2	Drill holes *D* in two pieces.	Jig to hold two pieces and two-spindle head.	
	3	Tap hole *A* in two pieces.	Note: Two machines on Operation 1.	
3 	1	Drill hole *A*.		Cast iron. 1 minute.
	2	Drill hole *B*.	Angle-plate jig with pilot in hole *A*.	
	3	Tap hole *B*.	Angle-plate jig with pilot in hole *A*.	
	4	Drill hole *C*.	Angle-plate jig with pilot in hole *A*.	
	5	Tap hole *C*.	Angle-plate jig with pilot in hole *A*.	
	6	Tap hole *A*.	Note: Operations 2 and 4 and Operations 3 and 5 performed on same machine.	
4 	1	Bore hole *A*.		Cast iron. 1¼ minute.
	2	Turn boss *B*.	Piloted turning tool.	
	3	Tap hole *A*.		
	4	Thread boss *B*.	Opening threading die. Note: Hole A is tapped from both sides with a 1½-inch taper pipe tap.	
5 	1	Bore holes *A* and *B*, face flange *C* and clean up surface *D*.	Combination boring and facing tool for two holes and two faces.	Cast iron. 2½ minutes.
	2	Turn diameter *E*, face flange *F* and clean up face *G*.	Combination turning and facing tool. Note: Two machines on Operations 1 and 2.	
6 	1	Rough-bore and chamfer hole *A* and face flange at top of hole.	Combination boring, chamfering and facing tool.	Cast iron. 5 minutes.
	2	Ream hole *A*.		
	3	Drill hole *B*.		
	4	Rough-bore holes *C*, *D* and *E*.	Stepped boring tool.	
	5	Ream hole *C*.		
	6	Tap hole *E*.		
	7	Bore and turn gland *F*.	Piloted comb. turning and boring tool.	
	8	Thread outside of gland *F*.		
	9	Bore hole *G*.		
	10	Tap hole *G*.		
	11	Bore hole *H*.		
	12	Tap hole *H*.	Note: All other holes drilled on multiple-spindle machine carrying two pieces.	
7 	1	Drill hole *A*, rough-bore hole *B*, face flange *C*, chamfer hole *A*.	Four-spindle drill head. Work is turned over twice.	Bronze. 2½ minutes.
	2	Finish-bore hole *B* and finish-face flange *C*; bore *D* and counterbore *E*.	Combination stepped boring, counterboring and facing tool which holds 1⅞ inch height.	
	3	Turn diameter *F*.	Piloted turning tool.	
	4	Thread diameter *F*.		
	5	Tap hole *B*.		
	6	Chamfer hole *D*.		
	7	True up face of flange *C*.		
	8	True up face *H*.		

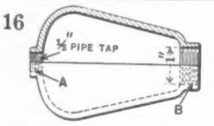
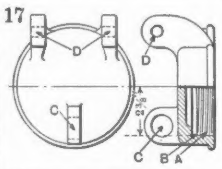
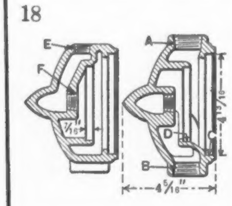
Machinery

LIST OF PARTS, ORDER OF MACHINING OPERATIONS AND RATES OF PRODUCTION

	Oper. No.	Operation	Notes on Special Features of Tool Equipment	Material Production Time
8 	1	Rough-bore hole *A* and face flange *B*, drill two holes *C*.	Four-spindle drill head. Work turned over once.	Bronze. 1½ minute.
	2	Finish-bore *A*, finish-face *B*, bore *D* and counterbore *E*.	Combination stepped boring, counterboring and facing tool.	
	3	Tap hole *A*.		
	4	Chamfer hole *D*.	Note: Holes C tapped on portable machine.	
9 	1	Drill hole *A*, bore and counterbore hole *B*, face flange *C*, chamfer hole *A* at *D*.	Three-spindle drill head. Work turned over twice.	Malleable iron. 1½ minute.
	2	Turn diameter *E* and face flange *F*.	Combination piloted turning and facing tool.	
	3	Thread diameter *E*.		
	4	Tap hole *B*.		
10 	1	Bore holes *A* and *B*; index fixture five times for these holes.	Indexing fixture and stepped boring tool.	Cast iron. 15 minutes.
	2	Face flanges *C* and *D* and counterbore holes *A*.	Combination counterboring and facing tool that holds height between faces *C* and *D*.	
	3	Tap five holes *A*.	Indexing fixture.	
	4	Chamfer holes *B*.	Indexing fixture.	
	5	Bore hole *E* and face flange *H*.	Combination boring and facing tool.	
	6	Bore two holes *F*.	Sliding fixtures to locate second hole for boring or tapping.	
	7	Tap two holes *F*.		
	8	Drill out seven cored holes *G*.	Note: Fixture is indexed five times to machine holes A and B.	
11 	1	Turn diameter *A*.	Turning tool.	Cast iron. 1½ minute.
	2	Thread diameter *A*.		
	3	Drill and countersink two holes *B*.	Four-spindle drill head—work turned once.	
	4	Drill hole *C* to depth shown; holes *B* tapped on portable machine.	Note: Holes B tapped on portable machine.	
12 	1	Bore hole *A* and face flange *B*.	Combination boring and facing tool.	Cast iron. 4 minutes.
	2	Turn diameter *C*, face flanges *D* and *E* and turn diameter *F*.	Combination turning and facing tool.	
	3	Drill two sets of three holes *G*.	Three-spindle drill head.	
	4	Chamfer hole *A* to 30 deg.	Note: Holes G tapped on portable machine.	
13 	1	Face flange *A* and bore hole *B*.	Combination boring and facing tool.	Cast iron. 3 minutes.
	2	Drill hole *C*.		
	3	Drill out six cored holes *D*.	Three-spindle drill head—two operations. Note: Two machines on Operation 1, hole C, tapped on portable machine.	
14 	1	Bore and counterbore hole *A*, bore hole *B* and face *C*; turn diameter *D* and face *E*; bore hole *F*.	Three-position fixture and multiple-spindle head; stepped boring and facing tool; combination turning and facing tool. Work reset three times.	Malleable iron. 2 minutes.
	2	Thread diameter *D*.		
	3	Tap hole *A*.		
	4	Tap hole *F*.		
15 	1	Bore and chamfer hole *A*.	Boring and chamfering tool.	Cast iron. 4 minutes.
	2	Ream hole *A*.		
	3	Drill hole *B*.		
	4	Bore hole *C* and turn diameter *D*.	Piloted boring and turning tool.	
	5	Thread diameter *D*.		
	6	Bore hole *E*.		
	7	Tap hole *E*.		
	8	Bore hole *F*.		
	9	Tap hole *F*.	Note: Operations 7 and 9 performed on one machine with two-position fixture.	

Machinery

LIST OF PARTS, ORDER OF MACHINING OPERATIONS AND RATES OF PRODUCTION

	Oper. No.	Operation	Notes on Special Features of Tool Equipment	Material Production Time
16 	1	Drill hole *A*.		
	2	Tap hole *A*.		Malleable iron. 1 minute.
	3	Drill hole *B*.		
	4	Tap hole *B*.		
17 	1	Rough-bore hole *A*.		
	2	Under-cut hole *A* at *B*.	Cam-operated under-cutting tool.	Malleable iron. 2 minutes.
	3	Tap hole *A*.		
	4	Drill hole *C* and two holes *D*.	Angle-plate jig and two-spindle drill head.	
18 	1	Bore holes *A* and *B*.	Angle-plate jig; work turned over to drill and tap hole *B*.	
	2	Tap holes *A* and *B*.		
	3	Rough-bore holes *C* and *D*.	Stepped boring tool.	Cast iron. 2½ minutes.
	4	Ream hole *C*.		
	5	Drill hole *E*.		
	6	Tap hole *E*.		
	7	Drill hole *F*.		
	8	Tap hole *F*.		

Machinery

Note: The time of each operation does not include an allowance for setting up machines or grinding tools, but does allow for changing dull tools for sharp ones. The time of setting up machines varies from fifteen minutes to half an hour per machine, depending upon the nature of the tools and fixtures which are required.

tions, it is believed by the management of the Bowser factory that the highest rate of production that is possible is obtained from each machine.

Organization of Department Management

Reference has already been made to the fact that in operating these machines, it is the practice never to have more than four machines working on the same piece; however, it occasionally happens, that the length of operations on a group of machines is such that the operator can perform the first operation on the group of four machines next to his own in less time than the other operator can perform the remaining three, in which case, the machines are divided up five and three between the two operators, although the parts being machined each require four machines. There is a set-up man in charge of the department who is under the jurisdiction of the general foreman, and it is the duty of this man to assist the operator in dismantling his machine at the completion of each job and in setting up the new jobs. He also sees that sharp tools are furnished to the operators at such times as they need them and can also substitute for any of the regular machine operators at such times as the latter are away, in order to keep all the machines constantly employed during the working days. Figs. 1A and 1B show the application of portable machines for performing an extra operation for which a machine is not available.

Special Equipment for Machines

Mention has already been made of the fact that the machines used for this work are the Baker No. 310 high-duty drilling machines. Standard machines were purchased, but in order to adapt them for the special requirements of this work it was found necessary to apply some additional equipment. Actual changes made in the machine details include the following: Provision of special gears in the feed train to allow for cutting threads of the desired pitches, including the 11½ pipe threads; provision of an automatically operated air cylinder on each machine for shifting the double belt drive, to provide for reversing the direction of rotation for backing out taps and backing off threading dies; and the provision of a special feed release mechanism which disengages the feed clutch but allows the spindle to continue rotating for the necessary length of time to insure the removal of tool marks when performing facing, chamfering and counterboring operations.

In this connection it might be mentioned that a special arrangement of counterweights is provided which are much lighter than the standard counterweights furnished on the machine. These weights are of the slotted disk type and the number of weights used can be such that the boring tool, tap, or die can either be just floated off the work or actually returned to the starting position automatically, so that all the operator has to do is to pull the spindle down and throw in his feed lever. The capstan placed in the base of each machine under the counterweight provides for regulating the height to which the spindle is raised so that the height of the spindle in its "up" position can be made to suit each job. It also prevents the spindle quill from striking the top of the machine in cases where heavy counterweights are used. This is accomplished by raising or lowering the capstan so that it stops the fall of the counterweight at just the required point.

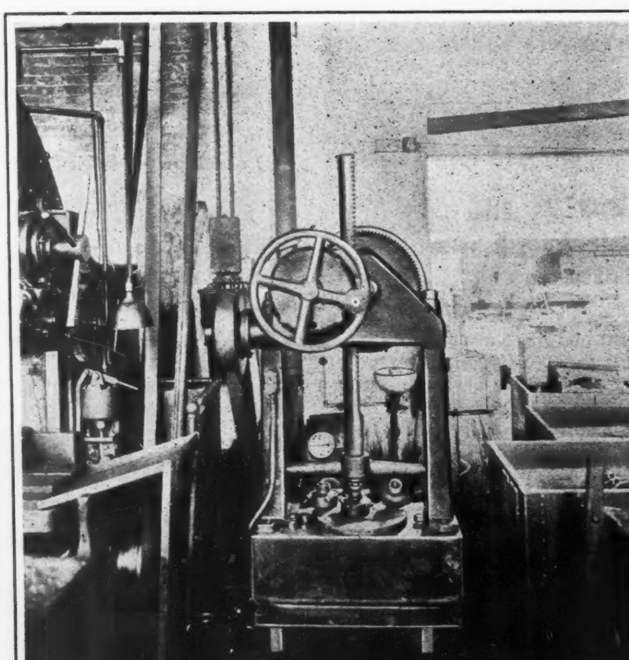


Fig. 1B. Arbor Press mounted on Skid so it can be set in Place to press in Bushings during Performance of a Sequence of Machining Operations

Special Provision for Threading and Tapping

On these machines, threading and tapping operations are performed on work where it is required to cut from eight to twenty threads per inch. On the Baker high-duty drilling machines changes in feed are obtained by first placing lever *A*, Fig. 2, in one of the three positions controlled by inserting a pin into holes in the dial over which

this lever rotates. Any of the rates of feed obtained in this way may be compounded through slip gears *B*, *C*, *D*, and *E*, which have 27, 33, 20, and 40 teeth, respectively. It will be apparent that both pairs of gears *BC* and *DE* have a total of 60 teeth, so that they may be placed on fixed centers, and by transposing gears *B* and *C* or transposing gears *D* and *E*, the three available rates of feed obtained for different settings of lever *A* are combined to give a total of 12 feed changes. The total range of feeds runs from 0.010 to 0.050 inch per revolution. This mechanism is standard for the Baker drilling machines with the exception of the fact that shafts *F* and *G* are made 5 inches longer than the standard dimension to provide for introducing special gears into the feed train in order to secure the desired rate of advance for the spindle when performing threading and tapping operations, which are the only operations for which these special gears are used.

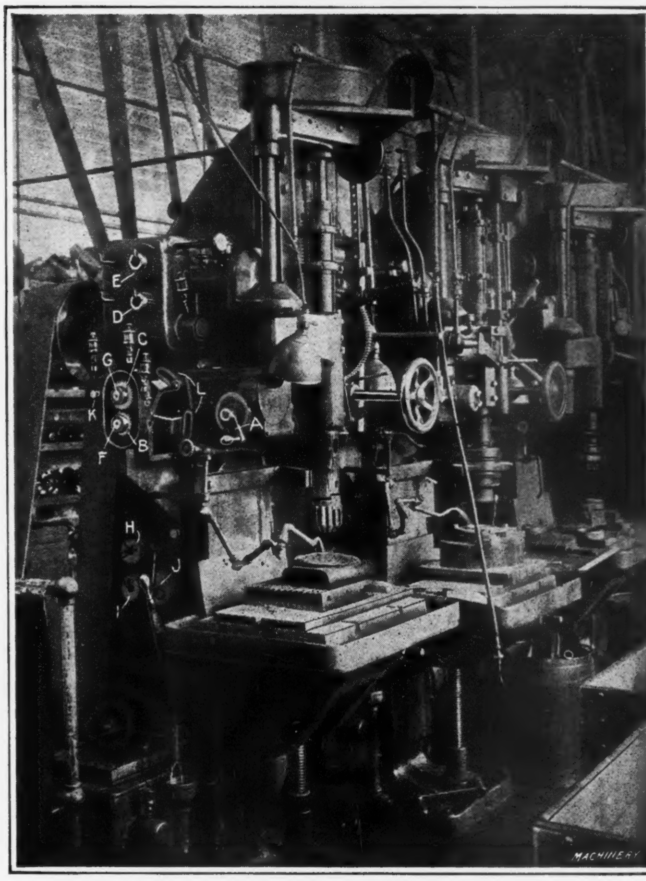


Fig. 2. Arrangement of Special Gears introduced into Feed Train to provide for performing Threading and Tapping Operations

When the machine is to be set up for threading or tapping, the first step is to remove the gears from shafts *F* and *G*. As a substitute for these two gears, one of the special change-gears *H*, *I*, or *J* is introduced into the feed train; this special gear has twice as many teeth as there are threads per inch on the work which is to be machined. For instance, a gear with 23 teeth is employed for threading or tapping work with the 11½ threads per inch commonly employed on pipe fittings. This gear is mounted on a pull-pin *K*, after which quadrant *L* is pulled up to readjust the position of the gears in the feed train so that this special "transposing" gear for threading and tapping operations is brought into mesh. Before starting threading or tapping it is necessary to remove the gears from shafts *F* and *G*, but if so desired the transposing gear may be left in place on the pull-pin *K* when the machine is used on other classes of work. When this is done, the gears are simply replaced on shafts *F* and *G* and quadrant *L* is dropped so that the transposing gear is no longer in mesh. Under such conditions, transmission is through the regular feed-gears on shafts *F* and and *G*. Hooks are provided for the feed change-gears and for the special gears for threading and tapping, so that there is little danger of their being misplaced when not in use.

Automatic Compressed-air Reverse for Threading and Tapping

Reversal of the direction of spindle rotation for the performance of threading and tapping operations is accomplished by the standard arrangement of forward and reverse belts furnished on the Baker high-duty drilling machines. A change in the method of operating these belts has been provided, however; instead of using a hand-lever, shifting of the belts is accomplished automatically by compressed air. At the right-hand side of two machines in each group of four, there will be seen a small air cylinder in which runs a piston that actuates the belt shifter.

A good idea of the way this mechanism operates will be obtained from the view of four machines, Fig. 3, and the detail views of the control mechanism, Fig. 4. At the left-hand side of the machine within convenient reach of the operator there will be seen a lever *A*, Fig. 3, which actuates the air valve. When this lever is thrown up it opens the valve to admit air to the under side of piston *B*, which forces this piston to the position at the top of the cylinder shown in Fig. 4. Connected to the piston-rod there is a rack *C* which meshes with a pinion on shaft *D*, by means of which the belt shifter is actuated to throw the "forward" driving belt onto its tight pulley, while the "reverse" driving belt is shifted onto its loose pulley. When it is desired to reverse the direction of rotation, lever *A*, Fig. 3, is thrown down to admit air into the cylinder above the piston, with the result that this piston is forced to the bottom of the cylinder. Through rack *C* and the meshing pinion carried on shaft *D*, the "reverse" belt is thrown onto its tight pulley and the "forward" belt is shifted to its loose pulley, which provides for backing out the tap or backing off the threading die.

So far we have considered the operation of this mechanism as if it were hand operated, but, as a matter of fact, the operation is automatic. By making suitable adjustment of hand-lever *E* at the top of the air cylinder, provision may be made for either stopping the machine or automatically reversing the direction of rotation. To stop the machine, lever *E* is thrown down, and the connection of this lever with link *F* and bell-crank *G* results in sliding bolt *H*

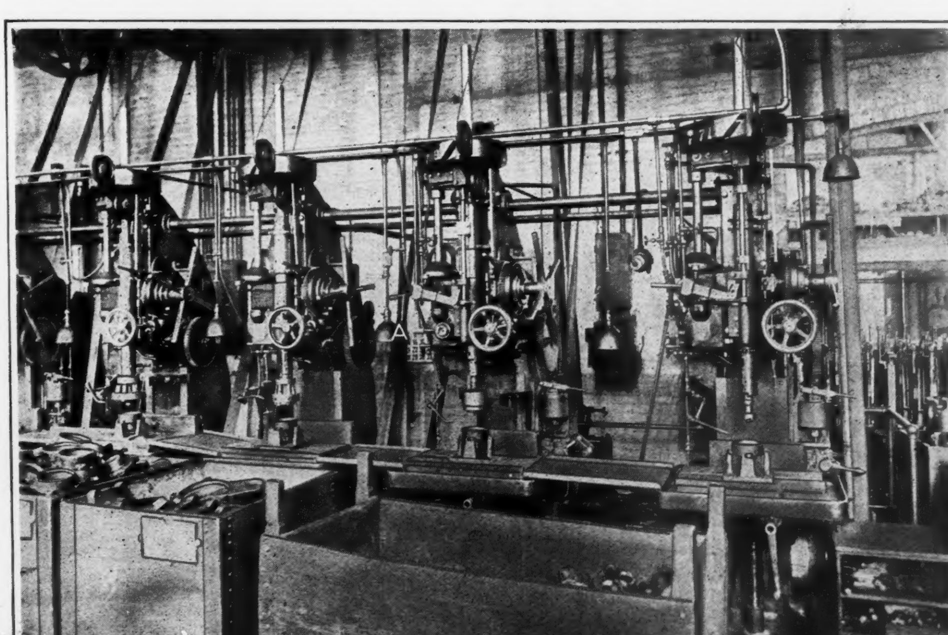


Fig. 3. Arrangement of Compressed-air Control for Spindle Reverse Mechanism for Threading and Tapping

to the right. In this position cam I, attached to the back of rack C, comes down until the flat bottom of this cam engages bolt H. In this position the forward belt has been shifted onto its loose pulley, but the reverse belt has not been shifted from its loose pulley to the tight pulley. As a result, both the forward and reverse belts are running on their loose pulleys, and so the machine stops.

If, on the other hand, it is desired to have the machine reverse automatically, lever E is pushed up so that bolt H is withdrawn. It is now possible for the piston to descend right to the bottom of the air cylinder, thus allowing rack C to shift the "forward" belt to its loose pulley and the "reverse" belt to its tight pulley. This reverses the direction of rotation of the spindle to back out the tap. In this position of the mechanism, cam I descends and engages with a corresponding cam surface on bellcrank J, which results in rocking this lever and raising rod K. This rod is connected to a link mechanism, which drops the feed worm out of engagement with the worm-wheel at the time that the reverse belt is shifted onto the backward driving pulley. Under these conditions the spindle is free, so that the tap or die can be backed off the work. A collar on the drilling machine spindle trips valve lever A to provide for reversing the machine at the bottom of the spindle travel, i.e., when the tap or threading die has reached the desired depth; and a second collar again reverses the machine ready for the next operation. To start the machine, it is merely necessary for the operator to throw the feed worm into engagement with the worm-wheel in the usual way.

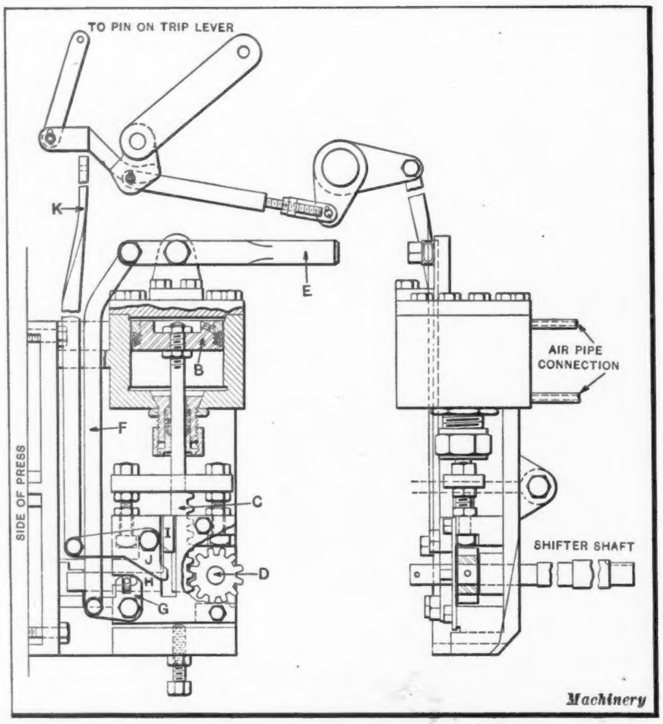
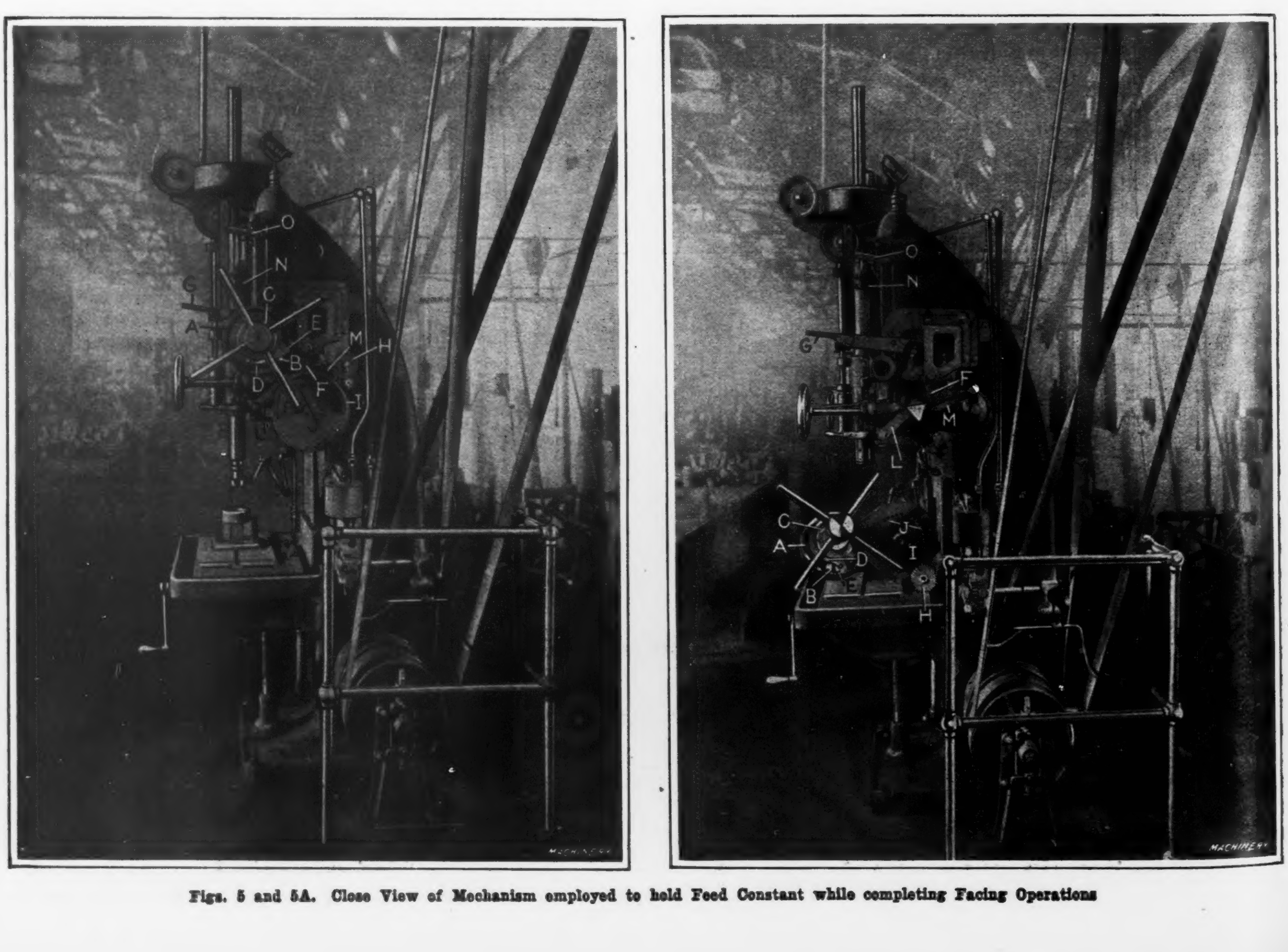


Fig. 4. Mechanism of Compressed-air Control for Spindle Reverse, shown in Place on Machine in Fig. 3

Connected with the same air line that supplies the cylinders for reversing the direction of rotation of the spindles for threading and tapping operations, connections are made at each machine with a flexible tube and metal nozzle, on which there is a push-button valve. This equipment is found convenient for blowing chips and cutting compound off the work after an operation has been completed. All bolts on the machine have standard heads to fit a single socket wrench.

It will be seen that there is a second pipe line running along at the top of the machines, this being provided to carry cutting compound to the machine from a single distributing station. Each machine has its individual electric light with a shade which protects the operator's eyes and directs all light down to the work. At each third machine, connection is made with a power circuit, the purpose of this being to provide for driving portable tools. The purpose of this is to allow a portable drilling or tapping machine to be brought into place for performing one or two operations in cases where the number of operations to be performed is such that they cannot be conveniently divided up among the machines. When not required, the portable machine is carried away on an elevating truck; it is mounted on a skid for this purpose. At each machine a safety plug is provided which may be pulled out to stop the main driving motor in case of emergency.



Figs. 5 and 5A. Close View of Mechanism employed to hold Feed Constant while completing Facing Operations

Provision for Holding Feed to Complete Facing Operations

There are a number of different parts that are machined on this battery of drilling machines on which it is required to perform facing operations. This work can readily be handled on drilling machines equipped with suitable facing tools, but where a fine, smooth finish is required—as in cases of couplings on gasoline pumps, etc.—trouble would be experienced through having tool marks show on the work if the facing head were simply advanced to the work until the feed mechanism was tripped automatically and the spindle returned to its upper position. To overcome this trouble, a special equipment has been furnished on all machines, which provides for disengaging the clutch at the end of the feed worm and still holding this worm in contact with the worm-wheel, so that the spindle continues to rotate with its position held stationary, as far as vertical feed movement is concerned. In this way the facing operation is completed without any tool marks being left. The same device is used to secure a smooth finish when performing chamfering and counterboring operations.

Two complete revolutions of the capstan wheel are necessary in order to obtain the full travel of the drill spindle. In working out the design of this mechanism for rotating a cutter without any feed movement, while completing a facing operation, provision had to be made for obtaining practically the full spindle travel to meet the requirement of those cases where it is necessary, before the feed is tripped. For this purpose the following means are employed, as shown in Figs. 5 and 5A. A disk A is bolted to the feed worm-wheel, and this disk has a circular T-slot milled in it to carry an adjustable dog B. Pivoted freely on the face of this disk there is a second member C on which there is arranged a lever D that may be pulled to advance a catch E out of the edge of disk C. This catch E ultimately engages the upper end of a bellcrank lever (the lower end of which is shown at F) which results in causing the lower end of this lever to disengage the clutch at the end of the feed worm shaft.

In operation, the position of dog B is adjusted in the circular T-slot in disk A, so that this dog causes catch E to trip the feed worm clutch when the spindle has reached the desired position. As two complete revolutions of the capstan wheel are required to secure the maximum feed motion for the spindle, it was necessary to employ the double arrangement of disks shown at A and C, in order that disk A can make a complete revolution to bring dog B to the opposite side of the lug on disk C, after which continued revolution of disk A causes dog B to carry disk C around. When this revolution has been completed catch E engages bellcrank lever F and trips the feed worm. Of course, any portion of the maximum feed movement of the drill spindle may be obtained by making a proper setting of dog B.

When the clutch has been disengaged on the feed worm shaft, it will be apparent that the worm is still in engagement with the worm-wheel, which prevents the counterweight from returning the spindle; at the same time, the spindle continues to rotate, thus completing the facing operation with a fixed vertical position of the cutter, so that the work is finished without showing any tool marks. To complete the cycle of operations, it will be apparent that the feed worm must be thrown out of engagement with the worm-wheel so that the spindle may be returned to the starting position. The mechanism provides means of doing this automatically, the operation being [illegible] lows: Th[illegible] eceding description has explained ho[illegible] ntact with bellcrank F and results i[illegible] sengaging [illegible] n the feed worm shaft. After this ha[illegible] done, it [illegible] ssary for pinion H to be brought into [illegible] h with gear I [illegible] order that a dog mounted in one of the holes J in gear I may engage with a link to throw the feed worm out of engagement with the worm-wheel.

After catch E has engaged with bellcrank lever F and moved this lever sufficiently to disengage the clutch on the feed worm shaft, catch E plays no further part in the operation. Carried by lever G there is a spring plunger with a roller at its end, which runs over the V-shaped block secured to the frame of the machine. At the same moment that catch E has disengaged the feed clutch, this roller carried by the spring plunger on lever G has reached the position at the apex of the V-shaped block. The spring behind the plunger is now compressed so that its maximum tension is exerted, and as the roller passes over the top of the vee the spring pressure becomes effective in causing the roller to run down the decline of the V-shaped block. In so doing, a further movement is imparted to lever G which has the following effect. Pinion H is carried on a quadrant, which has been gradually swung over during the time that catch E is in contact with bellcrank F. As the roller carried by the spring plunger on lever G runs down the decline of the V-block, movement imparted to lever G is transmitted through a link mechanism of which M is a part, which results in bringing pinion H into mesh with gear I.

As previously mentioned, a pin carried in one of the holes in this gear, trips the feed worm out of engagement with the worm-wheel. The counterweight then returns the spindle to its upper position. At this point collar N carried by the spindle engages lever O, which imparts the reverse movement to the mechanism which has just been described. In the first place, the quadrant which carries pinion H is rocked back so that this pinion is disengaged from gear I. Gear I is made heavy at what is the lower side in the starting position, and this gear is free on its shaft, so that when the pinion is disengaged, gear I is automatically returned to the starting position, where the heavy side of the gear is at the bottom. Bellcrank lever F and the extension G of this bellcrank are also returned to their starting positions ready for the next cycle of operations. When the operator has set up the next piece of work, he merely has to engage the feed worm with the wheel, after which he goes on to the next machine.

* * *

EMPLOYMENT OF WOMEN IN MUNITION FACTORIES

In a paper read before the British Institution of Mechanical Engineers, O. E. Monkhouse called attention to the many difficulties that were met with in the introduction of women into machine shops. A large proportion of the women employed were not accustomed to factory life and discipline; most managers and foremen were not accustomed to managing women workers; the shop conditions were planned with a view to the employment of men; and the women were unaccustomed to the use of machinery. Besides, there was the difficulty of maintaining discipline in a mixed shop. Other difficulties were the long hours and the question of physical strength. At the present time, nothing but harm can be done by praising the power of women too highly, but there are many cases where women have shown great ability and have acquired a knowledge of certain branches of shop work greater than that which would have been obtained by an apprentice in the same period under prewar conditions. This state of affairs is due largely to the fact that women have been definitely taught, whereas the apprentices had to pick up their trade; that women have, for the most part, been extensively taught everything in the shop itself under production conditions, rather than in an apprentice school; and that present conditions have actuated and spurred on everybody to greater effort from patriotic motives. There is little doubt that the advantage of getting their training under production conditions has been instrumental in speeding up women's training.

It is extremely difficult to start women in the same shop with men unless the latter are in sympathy with the movement. Experience has shown that the only satisfactory way is to start women in a shop by themselves under a broad-minded foreman. Government training schools have done much in England by supplying a nucleus of trained labor to the shops; while a few large firms have started their own training schools.

There is no doubt that, generally speaking, a woman is a better judge of a woman than is a man; so in England successful firms have experienced women supervisors who hire all the women workers. In one case, where some of the women were chosen by a woman and the rest by a man, there was great complaint of the efficiency of the women hired by the latter; investigation showed that those women who were rejected by the woman were generally engaged by the man.

ROUTING AND HANDLING SHELLS

GENERAL PRODUCTION METHODS AND SHORT-CUTS ON LARGE SHELLS

BY JAMES FORREST [1]

WHEN a large contract is received many important questions arise. If the job is entirely different from anything that has been done before, as is generally the case with a shell contract, the first questions to be decided are whether the work can be handled with the equipment already at hand; whether this equipment can be altered and rearranged to advantage; or whether an entirely new shop with an installation of machines for the purpose will be necessary. In most cases the last course will be found advisable on account of the magnitude of munition contracts, the money involved, and a consideration of the great handicap under which ordinary machine tools labor in comparison with single-purpose machines built expressly for the hardest and roughest use.

The following points should be borne in mind when selecting munition machinery: The machines must be able to run twenty-four hours a day, which means the working parts must be more liberally proportioned than is usually the case, and the members that support the working parts must be so sound, solid, and rigid, that there will be no vibration under the most trying conditions. It should be remembered that these machines will be expected to produce many times in excess of preconceived ideas of production, that the cry will always be for more, and that in many cases, far from being set on a solid concrete base, the machines are set down on cinders that cover what only a few weeks previously may have been a swamp. The machines will also be run for long periods without proper care by irresponsible men who will handle them roughly.

A machine may be large, heavy, and coarse looking and yet not have the required strength. It is not enough to simply look at a machine and then say, "Oh, it looks heavy enough, I guess it is all right." It is necessary to study its parts and get down on one's back to see that it is all right. For instance, a heavy, rugged, boring machine, built by a reputable firm, though a new one, which was well proportioned and designed, had a weak point in one of the walls of the carriage. When one machine after another broke in service, an investigation showed that the side of the carriage which took all the thrust of the cut was only half as strong as the trailing side. Convenience is another point to be kept in mind. When it is considered how many times a day and for how many months the various operating parts will be actuated, it will be realized that they should be easy of access, easy working, and not likely to get out of order.

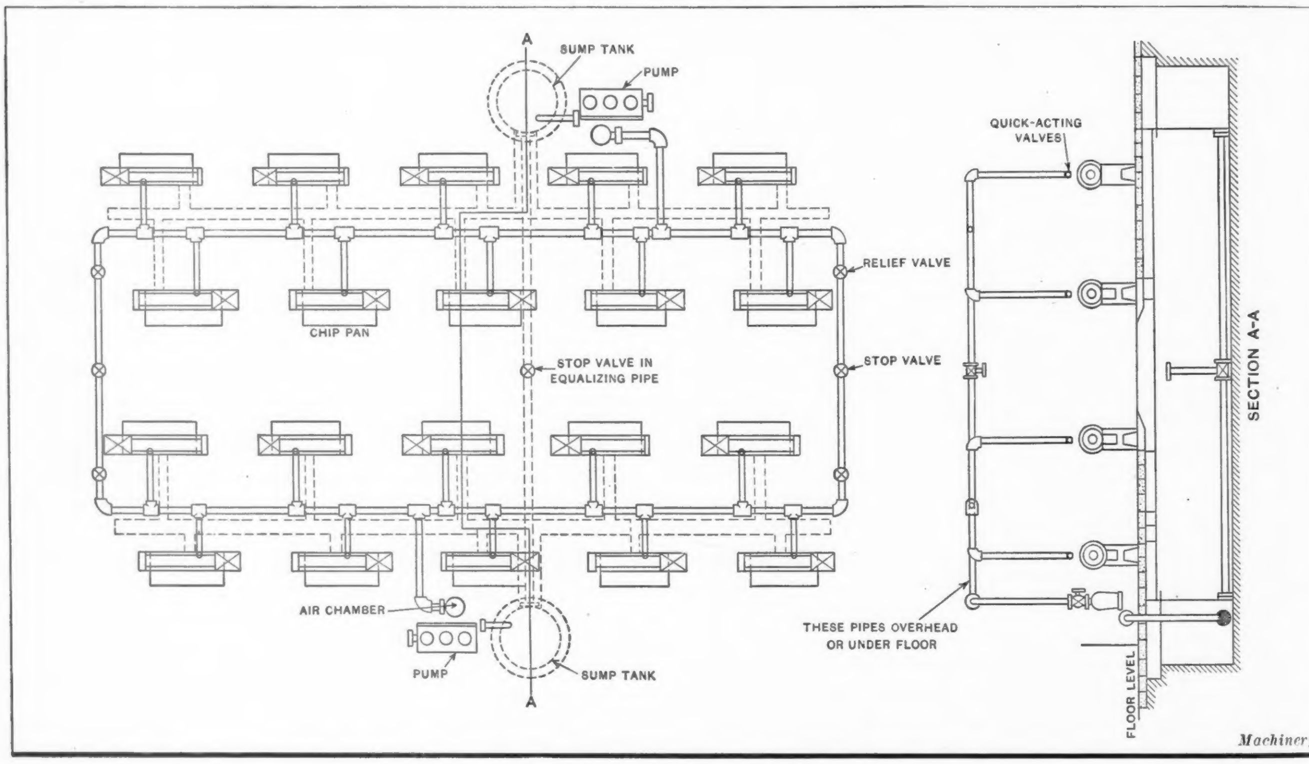


Fig. 1. Lubricant Drainage System

Routing the Work

Side by side with the purchase of machinery comes the problem of arranging it in place. This problem will, in a way, solve itself if the attention is focused on the place where the rough forgings must be brought in and where they must be shipped when completed. If the shipping station is at the opposite point of the compass from the receiving station, and there is enough space between these points for the different operations, the routing of the product will follow a direct line from one point to the other in progressive steps. If two sizes of shells are being made, a double line of shops may be built with store-rooms, tool-rooms, offices, and other adjuncts that apply to the product as a whole, placed in between; or the heavier shells can pass along the first floor and the lighter along the second. If the shipping point is at the same end as the receiving point, the product may be elevated to the second floor, passed along until half completed, and then dropped to the first floor and sent along back to the shipping point. Of course these suggestions will be modified by a consideration of the various or[illegible]tions; for in[illegible]e, heavy hammering cannot be done o[illegible] principal thing is to have the product foll[illegible]t it will not double back at any stag[illegible] path, as this means more men to handle it and much [illegible]s of time in co[illegible]nce.

If a new shop must be constructed, the floors should be made of concrete, thus providing the proper foundation for the machines at the beginning. The floor of rooms where machinery using cutting fluid will be installed should have the chip troughs, with connecting ducts to the main return conduits, incorporated as a part of the concrete floor. Then all troubles due to leaky or clogged return pipes will be prevented, the machines will turn out better work on account of less trouble from vibration, and the chips will be easier to

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remove, as the troughs under the machines can be made with an incline at the rear, up which the chips may be raked. Besides, the floor can be kept in a much more sanitary condition on account of the ease with which it may be flushed, and it will be drier and more comfortable for the men, as all liquid will drain off into the ducts and troughs. A platform of wooden slats may be placed for the operators to stand upon. The concrete floor will also present a much better surface for transportation of machines, supplies, and products, than any other material, thus effecting a saving in tires and the power consumption of transfer trucks.

WEIGHT OF FRENCH SHELLS DURING PROCESS OF MANUFACTURE

Operation	220-millimeter Shells		270-millimeter Shells	
	Weight before Operation, Pounds	Loss of Weight, Pounds	Weight before Operation, Pounds	Loss of Weight, Pounds
Forging	355.500	.....	528.50	.....
First cut to length	319.500	36.00	433.50	95.00
Rough-turn	244.000	75.50	348.00	85.50
Bore	203.000	41.00	307.00	41.00
Base cut	188.500	14.50	286.50	20.50
Finish shell (no band)	161.145 +	27.35	237.39 +	49.11
	155.450 —	33.05	227.83 —	58.67
Average total weight lost	....	197.20	......	295.90

Machinery

Handling the Work

After a plan of routing has been developed and the location of machines decided upon, much time and study should be devoted to the details of handling the shells from the time they are received from the steel mill through the sequence of operations until they are finally shipped. These details will depend greatly on the weight of the shells at each operation. More expense can be saved by foresight at this time than at any other, for while machines may be speeded up without cost, and production increased thereby, in most cases it costs a great deal of money to change a faulty system of handling as new equipment must be bought.

The motions that are most often repeated are those upon which attention should be concentrated. If the shells, as soon as an operation is completed, are placed in the position to be lifted into the machine for the next operation, a material saving in time will result. For instance, when unloading shells from a car, if the only object were to empty the car in the shortest possible time, a lifting magnet could be used to raise the shells over the side of the car and they could be dropped wherever room could be found. But the shells would have to be twisted, wedged, and levered out of the pile again, one by one, to start them off to the next operation. A better plan is to pile them in regular formation on an elevated platform so that they may roll down by their own weight to the next operation.

The installation of a complete monorail system, together with electric hoists, around the aisles between the machines, with switches and sidetracks to carry the shells in to the machines, will give the best results in facility and low cost of handling. If the transferring between operations is done on the floor, each shell must be hoisted to the height of the machine centers and lowered back to the floor again, two lifts for each operation. With standardized lifting devices, a stop can be applied to the hoist so that the shell is automatically stopped when it is raised to the correct height to be placed in the machine. This monorail system can be easily arranged so as to feed into a main aisle where an electric traveling crane will handle all the shells in large quantities.

The operations on French 220-millimeter and 270-millimeter shells, from the time the forgings are received until the shell is finished are as follows: Unloading from car, rolling into shop, pickling, inspecting rough forgings, marking for cutting off, assigning serial numbers, cutting off to length, centering, rough-turning, inside boring, base cutting to exact thickness, nosing, heat-treating, nose boring and facing, threading nose, finish-turning, grinding bourrelet, washing, sand-blasting, hydraulic testing, banding, band turning, finish inspection, boxing and shipping. The weight of the shells during the different stages is given in the accompanying table.

Machinery for shell work ought to have individual motor drives to avoid the delays caused by belting systems. If a belt comes off, even on one unit, that unit is thrown out of action and the other units in the system are idle while the belt is being put on. Even after the lineshaft is running again, it will be some little time before the machines are running with the same efficiency as before. Some of the operators will have discovered they are hungry, or need a chew of tobacco, or a drink, and so on; perhaps the pump will have to be primed; or someone may break a tool picking up a cut again. If the main driving belt gives trouble, the effects of the shutdown are increased a hundred fold. When consideration is taken of these facts and of the initial cost and the upkeep of lineshafting, pulleys, belting and belt-shifting mechanisms, of increased danger to life and limb that the care of these things entail, and of the restrictions they impose on the installing of shell-handling appliances, it will be seen that the balance is in favor of individual motor drive. With such a drive, an automatic overload cut-out placed in the motor circuit will save many an expensive tool.

On a long contract of any kind as much care and forethought as the circumstance will permit should be expended on the evolution of methods for making the series of actions

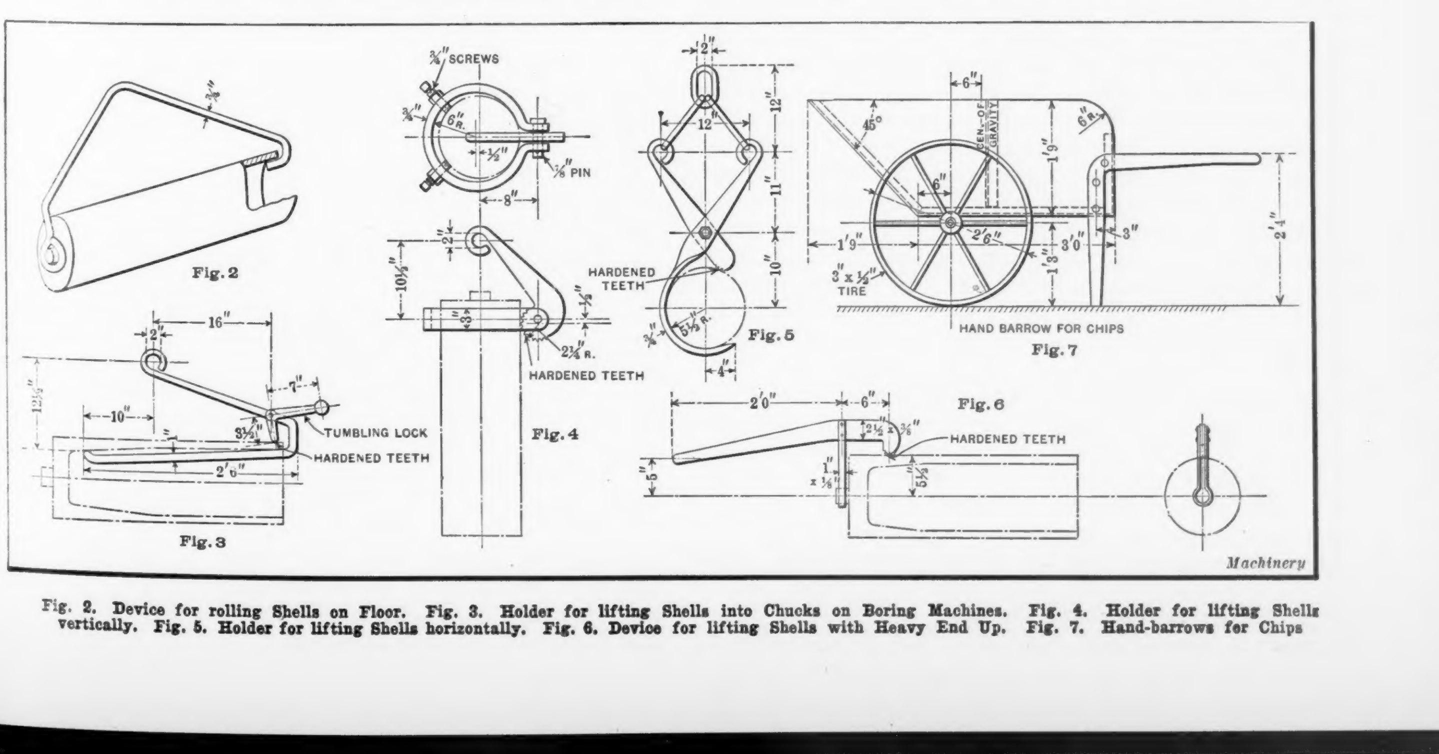

Fig. 2. Device for rolling Shells on Floor. Fig. 3. Holder for lifting Shells into Chucks on Boring Machines. Fig. 4. Holder for lifting Shells vertically. Fig. 5. Holder for lifting Shells horizontally. Fig. 6. Device for lifting Shells with Heavy End Up. Fig. 7. Hand-barrows for Chips

that the operators must frequently perform as fast and easy as possible. Nuts that must be loosened and tightened many times a day can often be replaced by cams with handles attached. The same result may also be obtained by having two wrenches for the nut; one a very short light-weight wrench for putting the nut down fast and the other a regulation wrench for tightening it. All wrenches should be of the proper weight and balance to make their use as little tiring as possible and they should have hard jaws that exactly fit the nuts. Double-end wrenches can be used for parts near each other that are adjusted at the same time. The best of the odd tools and appliances the more intelligent workmen gather around their machines, in order to increase their piecework pay, should be standardized and supplied to all. Valves for the cutting compounds should open and close immediately instead of being of the slow screw-down variety seen in many shops.

All machine bearings should be fitted with self-feeding lubricators dropping into a waste-packed cap and the cap should be attached by a chain, or a hinge to the bearings. These lubricators should be filled by a man hired for the purpose. If these precautions are not taken, the bearings of many of the machines will run dry and the machines will not have a lubricator when they have been in operation perhaps but a month. Glass should not be used in these lubricators as there is continual breakage. Electric or air hoists, depending on what is adopted as standard, will tend to multiply production when judiciously placed, and will also relieve the men of much hard, tiring work.

Handling Cutting Compound and Chips

Pumps for cutting compound should be so placed that one is always in reserve in case of breakdown, also piping systems should be installed, so as to be easily accessible for the removal of obstructions. Stop-valves should be introduced into the line so that all the machines need not be shut down in case an obstruction or blow-out occurs in one part of the piping. A practical arrangement is shown in Fig. 1, where the pipes run in a double row, connected by a cross-over pipe with stop-valves inserted, and there is one pump on each row of pipes. This arrangement will give the least number of shutdowns on the machines for pump trouble. The sump tanks, if there are more than one, should be connected by an equalizing pipe with a stop-valve for use when cleaning the tank or during breakdowns. The return from the machine pans to the sump tanks should be of a very large diameter. It is preferable to have the return flow back through an open concrete duct covered with trap boards which are easily removed for cleaning the dirt. At various points in this trough, wire screens should be placed to remove the chips and rubbish that invariably find their way into the fluid and clog the pump valves if not removed.

The pipes should be well supported to take care of the vibration. As a pressure of at least one hundred pounds per square inch will be required on the boring operations, there should be proper relief valves and air chambers in the system. The pans under the machines should be large and deep, in proportion to the machine, to take care of the strong flow of the compound and the accumulation of chips. Some cutting compounds become rancid after a period of rest, as on a Monday morning and the smell causes some of the operators to become sick. This smell can be eliminated by applying crude carbolic acid frequently and in small quantities. The best way to apply the acid is to have an ordinary self-feeding lubricator behind each machine and drop the acid continuously into the troughs.

For handling the chips in the machine bays hand-barrows fitted with two wheels of very large diameter, and of such construction and balance as to be easily tipped and dumped, will be found convenient. The wheelbarrow shown in Fig. 7 throws little weight on the man wheeling it. These barrows are dumped into large hopper-bottom bins, fitted with lifting hooks, sunk flush in the floor in the main aisle, where the traveling crane can pick them up and dump them into the cars. The cutting compound may be drawn off the chips while they are in the bins by having a tank underneath each to receive the drip, or a centrifugal separator may be used. By this means it will be unnecessary to wheel the barrows long distances and up gang planks into cars.

Methods of Obtaining Maximum Production

On repetition work of any kind an effort should be made to place everyone in any way connected with the work on a piecework basis. It is quite possible, with the cooperation of the shop executives, to accomplish this, and make it apply to laborers, oilers, beltmen, inspectors, and repairmen, though, of course, it will not be possible at the beginning of a new job to do this. The supervising force, from the foremen up, should have a salary and a percentage depending solely on the output. By this means there is a zest and force impelled into the organization as a whole, making for increased production.

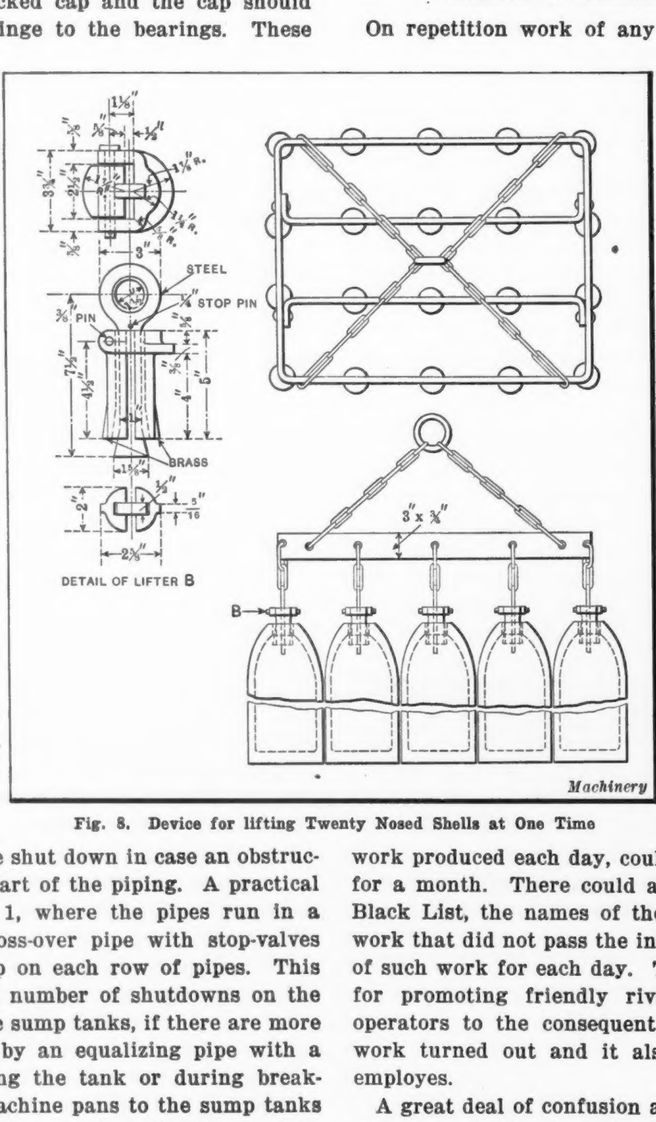

Fig. 8. Device for lifting Twenty Nosed Shells at One Time

Two good methods might be used to increase production and quality of work. A small prize could be offered each week, on each operation, for the operator who has produced the largest number of pieces that pass the inspector for that week, and his name, together with the quantity of work produced each day, could be posted on the bulletin board for a month. There could also be posted, under the heading Black List, the names of those operators who have produced work that did not pass the inspector, together with the amount of such work for each day. There is no more valuable method for promoting friendly rivalry and discussion among the operators to the consequent increase and betterment of the work turned out and it also gives a check on undesirable employes.

A great deal of confusion and loss of time can be eliminated if each operation is assigned a color. Each shell, after the operation has been performed and inspected, should have a ring about two inches wide painted round it with the operation color. This band will be more visible and full of meaning than the inspector's obscure stamp to those responsible for pushing the shells onto the next operation. The foreman, or anyone interested, can tell at a glance whether the shells are in a place where they do not belong and immediately take steps to have them moved. There is not as disagreeable a job as grubbing among a lot of unidentified shells, searching for the almost effaced inspector's stamp. If the stamp is not found, there is always the uncertainty that it has been missed. The rooms where the different operations are performed may be named the "black" room, "red" room, or whatever color may have been assigned to the operation, and if a shell with any other than the operation color finds its way into a room that shell should at once be ejected.

Shell Handling Appliances

Fig. 2 shows a device that may be used to good advantage when a few shells have to be moved a short distance along the floor; this holder can be taken into corners and through contracted spaces if necessary. Fig. 4 shows a device for lifting shells vertically as in centering machines, etc.; it will be seen that this has two screws for adjusting when the teeth wear. Fig. 5 is for lifting shells horizontally into machines, like lathes. The action is such that if the shell is not caught exactly at the center of gravity, it is prevented from sliding through and injuring the operator.

Fig. 3 shows a device for lifting shells into machines with long chucks as in boring machines. This is an example of a highly dangerous device converted into one that is perfectly safe by the application of a quick and efficient safety lock actuated by the operator's hand. The device shown in Fig. 6 is used for lifting shells up on end. It is very necessary, for without such an appliance it is a difficult job to raise a shell up with the heavy base uppermost, and in one case at least, to the writer's knowledge, a man was injured through attempting to lift the shell without this device.

Fig. 8 shows an apparatus for lifting and placing twenty nosed shells in regular formation; it consists of a steel frame with twenty lifters slung from it. These lifters *B*, as shown in detail, consist of two hinged brass grips that are expanded by a central sliding steel piece. This device can be used for lifting shells that have been threaded without damage to them. If it were desirable the frame could be made larger to suit the work being handled.

* * *

HOLDER FOR GRINDING ACCURATE THREAD-CUTTING TOOLS

The thread-cutting tools used by the Blair Tool & Machine Works, Inc., 515 Greenwich St., New York City, for making thread gages and for other precision screw-cutting operations

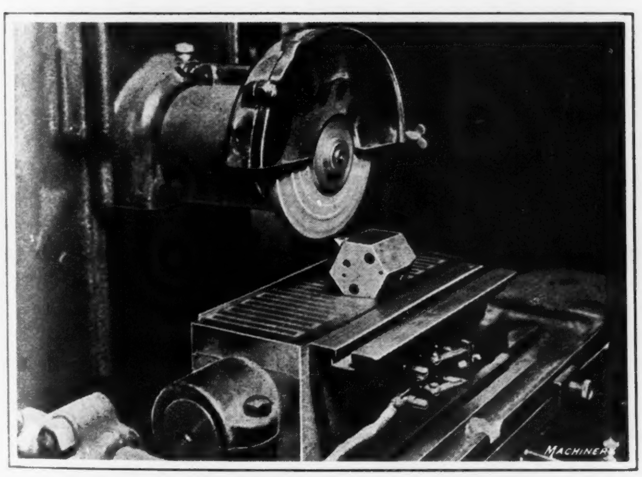

Fig. 1. Grinding One Side of Thread-cutting Tool on Surface Grinder

are ground on the surface grinder, as illustrated in Figs. 1 and 2. The cutting point or tool, which is held in a tool-holder while in use, is fastened in a block, mounted on the magnetic chuck of the surface grinder. Fig. 1 illustrates the position of this block for grinding one side of the tool, and Fig. 2 illustrates how the top surface or face is ground. In one case, the side of the block is placed against the plate, and in the other, the end surface. This block holds the tool in such a position that it is given a clearance angle of 15 degrees and at the same time is ground to the standard included angle of 60 degrees in the plane of the cutting face. The diagram Fig. 3 illustrates more clearly the relation between the sides of the block and the tool. The sides *A* and *B* are used for grinding U. S. standard thread tools. The sides *C* and *D* are used when grinding Whitworth thread tools. When using sides *C* and *D*, the tool to be ground is inserted in end *E* of the tool slot.

In making a block of this kind, it is necessary to modify the angles between the sides and the center line of the tool-holding slot, so that the cutting edge of the tool will be ground to

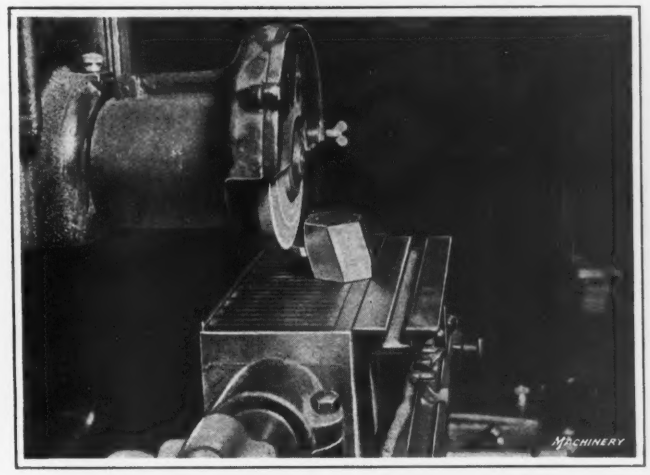

Fig. 2. Grinding Top Face of Tool on Surface Grinder

the correct included angle in the plane y–y of the top face. This means that the angle of the tool in a plane x–x at right angles to the front edge will be somewhat greater than 60 degrees; consequently the angle α between the sides which rest against the chuck and the center line of the tool must exceed 30 degrees. The tangent of

$$\text{angle } \alpha = \frac{\text{tan one-half of thread angle}}{\text{cos front clearance angle of tool}}.$$

Assuming that the clearance angle is 15 degrees and the thread angle 60 degrees,

$$\tan \alpha = \frac{\tan 30 \text{ degrees}}{\cos 15 \text{ degrees}} = 0.5977, \text{ and angle } \alpha = 30$$

degrees 52 minutes; therefore, the tool is ground to an included angle of 61 degrees 44 minutes in a plane at right angles to the front edge, in order to obtain an angle of 60 degrees in the plane of the top face.

The end surfaces of the block are parallel with the tool-holding slot, which is inclined to correspond to the front clearance angle of 15 degrees. It will be noted that just above the tool there is a vertical surface, which simply provides clearance for the wheel when grinding the top face. This block is formed of two sections, which are held together by screws and dowel-pins. The joint between the two sections intersects the tool-holding slot and is parallel with the end surfaces.

F. D. J.

* * *

The following figures have been sent out by the Signal Corps, Aviation Section, of the materials necessary for a single airplane of the more simple type, and exclusive of all the materials necessary for the engine: nails, 4326; screws, 3377; steel stampings, 921; forgings, 798; turnbuckles, 276; veneer, 57 square feet; wire, 3262 feet; varnish, 11 gallons; dope, 59 gallons; aluminum, 65 pounds; rubber, 34 feet; linen, 201 square yards; spruce, 244 feet; pine, 58 feet; ash, 31 feet; hickory, 1½ foot.

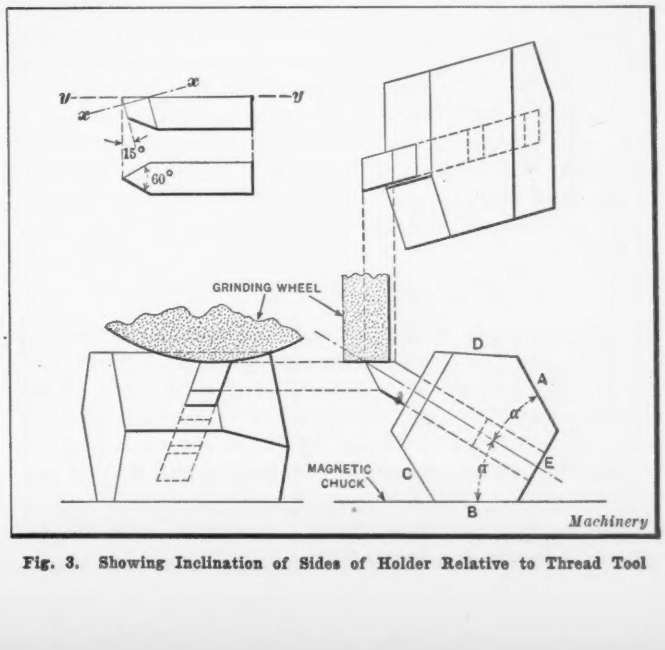

Fig. 3. Showing Inclination of Sides of Holder Relative to Thread Tool

OPERATING THE GRIDLEY AUTOMATIC TURRET LATHE—1[1]

COMPLETE INSTRUCTIONS FOR TOOLING SETTING-UP, AND OPERATING

BY DOUGLAS T. HAMILTON[2]

THE Gridley automatic turret lathe is of the single-spindle type. It has three cam-drums for operating the various mechanisms. The main drum, which is located at the left-hand end of the machine, carries cams for operating the work-holding and feeding chucks and the tool-slides on which the end-working tools are held. The turret has four slides, and hence must be indexed four times for each revolution of the camshaft. When the corner stop is used, a fifth indexing is necessary. The indexing of the turret is accomplished by dogs carried on a drum located near the center of the main camshaft; this drum also carries dogs for operating the fast and slow feeds. The third cam-drum, located at the right-hand end of the camshaft, carries the cams for operating the forming slide and the cutting-off slide.

As each tool-slide is operated by a separate cam and as the travel of each slide is governed by the length to be turned, drilled, etc., it is necessary to select suitable cams, and in some cases, to cut the standard cams or make special ones. It is, therefore, necessary for the operator to understand how to lay out these cams in order to operate the machine at its highest efficiency. The cams are laid out with relation to the main cam-drum, which makes one revolution in forty-two minutes on the slow feed, and one revolution in thirty-six seconds on the fast feed, the latter being used for the idle movements. The cams are laid out so that they advance the slides a certain specified distance per inch of circumferential travel of the drum on which they are held. In laying out any particular job, however, the first question to settle is the speed at which the work is to be rotated; this is governed by the diameter of the work, nature of the material, and character of the operation. In order to illustrate the procedure, a practical example will be taken and each step described.

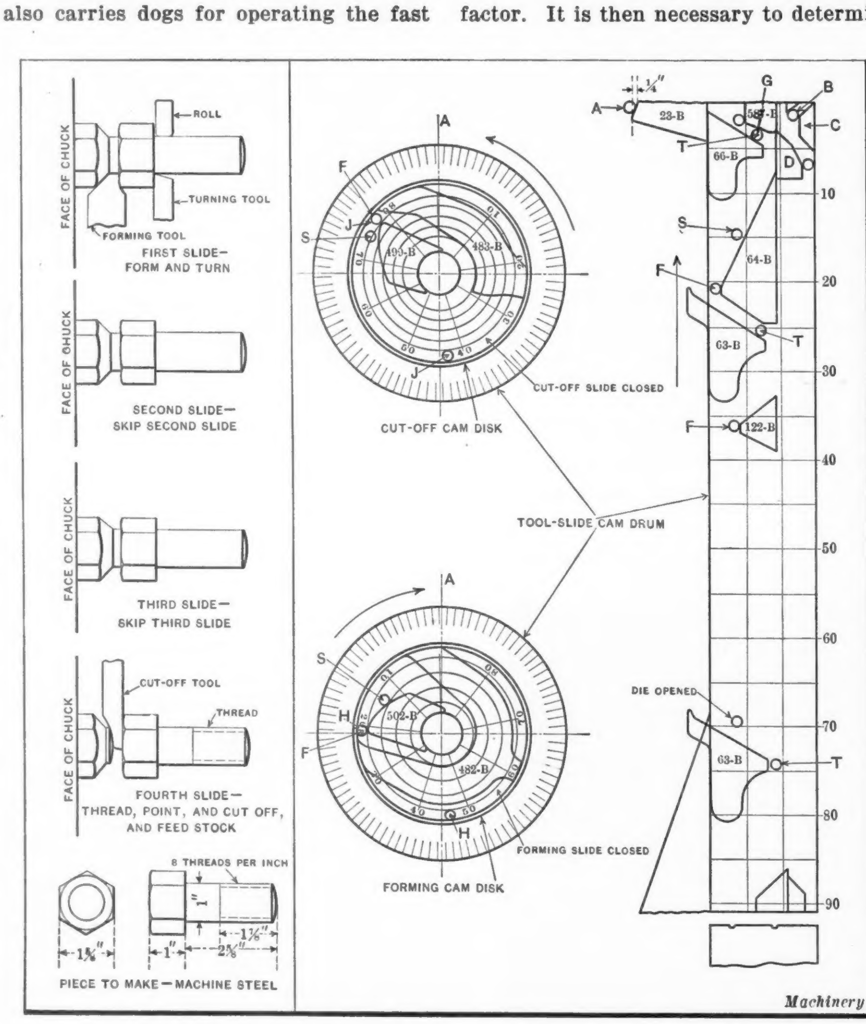

Fig. 1. Order of Operations and Lay-out of Cams for making Cap-screw

Method of Tooling

The shape and size of the part to be made largely govern the method of tooling that should be employed; the type of tools used also must be considered. In making a cap-screw of the form shown in Fig. 1, the forming tool is used for breaking down and chamfering the head, the box-turner on the turret-slide is used for turning, and the cutting-off tool cuts off and points the next screw. The threading, as a rule, is done with an opening die, which eliminates backing off the die.

After having decided on the order of operations and the tools to be used, it is necessary to determine the number of revolutions required to complete the cut and to select the cam to use. When the part to be made is to be threaded, two spindle speeds are usually necessary, especially for steel parts, so that all the other operations are performed at one spindle speed. As a general rule, the speed at which the forming cut can be satisfactorily taken may be considered the deciding factor. It is then necessary to determine the spindle speed required, which is governed by the diameter of the bar and the material. As most screw-machine tools are made from high-speed steel, a speed at least 25 per cent greater than would be possible with ordinary carbon tools may be employed.

The screw shown in Fig. 1 is to be made of hexagonal machinery steel, 1 5/8 inch across the flats, or 1 25/32 inch across the corners; hence the screw will be produced on a 2 1/4-inch machine. A surface speed for the work of 100 feet per minute will require a spindle speed of approximately 215 revolutions per minute.

Selecting Turret Feed-cam

The drum that carries the cams for operating the tool-slide has a circumference of 91 inches; and as it makes one complete revolution, on the slow feed, in forty-two minutes, it evidently travels 91 ÷ 42 = 2.166 inches per minute. As shown in Table 1, several cams having different angles of rise are provided, so the problem is to select a cam having a rise sufficient to give the desired feed with a certain spindle speed. Fig. 1 shows that the turning tool must take a heavy cut, and so the cam having the slowest feed will be selected. The cam designated by the manufacturers as 64-B, Table 1, advances the tool-slide 0.4663 inch per each inch of circumferential travel of the drum; or, in other words, it advances the tool-slide at the rate of 1.01 inch per minute. The rise of the cam, in inches, per inch of travel of the drum is equal to the tangent of the angle on the cam; so the rise or advance per minute is found by multiplying the advance per inch of circumferential travel by 2.166.

It is next necessary to see if cam 64-B will give a suitable feed with the work rotating at 215 revolutions per minute. The feed of the tool per revolution of the work is found by dividing the feed of the cam per minute by the number of revolutions of the work; thus, 1.01 ÷ 215 = 0.0047 inch. As the length to be turned is 2⅝ inches, with a feed of 0.0047

[1] For previous articles on Gridley multiple-spindle automatic screw machines, see "Operating the Gridley Multiple-spindle Screw Machine," May, 1918, and articles there referred to.

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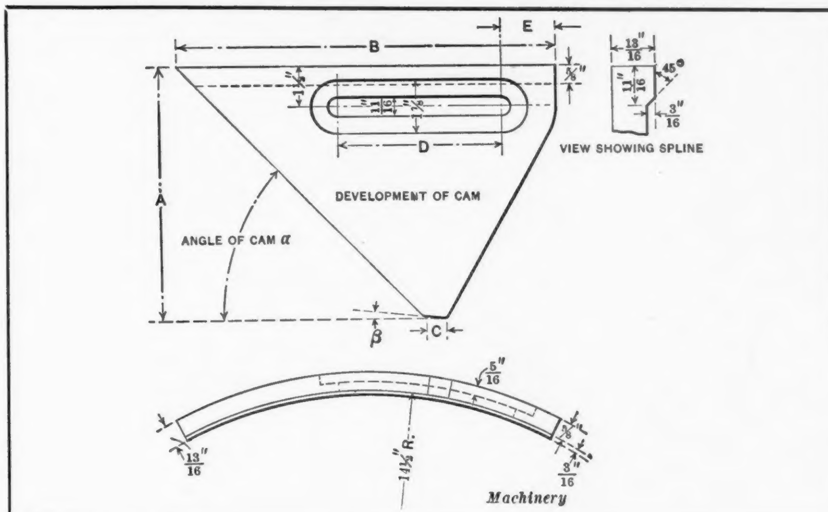
inch per revolution, it will require 458 revolutions to make the complete cut.

Selecting Forming Cam

Reference to Fig. 1 will show that the forming tool is not required to take a wide cut; hence it will stand a comparatively heavy feed. Table 2 shows that there are three forming cams provided; so the one giving the coarsest feed, or that designated as 502-B, will be taken. The forming tool is required to travel a distance equal to 1/2 (1 25/32—1), or 0.391 inch. Cam 502-B has a total rise of 2½ inches and will more than cover the distance. As this cam advances the forming slide at the rate of 0.3384 inch per minute, and as the work is rotating at 215 revolutions per minute, the feed per revolution is evidently 0.00157 inch. This is satisfactory under the conditions, and as the time required to take the forming cut is much less than that required for turning and the operation is accomplished at the same time, it need not be taken into consideration in determining the time required to complete the part.

TABLE 1. DIMENSIONS OF STANDARD TURRET FEED-CAMS USED ON GRIDLEY 2¼-, 3¼-, AND 4¼-INCH AUTOMATIC TURRET LATHES



Number of Turret Cam	Angle α of Cam, Degrees	Angle β Deg.	Advance of Slide, Inches per Minute	Advance of Slide per Inch of Drum Travel	Principal Dimensions of Cams, Inches				
					A	B	C	D	E
64-B	25	..	1.0100	0.4663	6	16¾	¾	4 13/16	2 11/32
154-B	25	..	1.0100	0.4663	8	18	..	5 5/16	2 23/32
278-B	28	5	1.1516	0.5317	9	19	⅜	7	2 1/16
62-B	30	..	1.2504	0.5773	6¼	14⅜	¾	5 5/16	2 3/16
61-B	38	..	1.6923	0.7813	6¼	11½	¾	4 1/16	1 27/32
122-B	40	..	1.8175	0.8391	3⅞	5¾	7/16	..	1 11/16
60-B	45	..	2.1666	1.0000	6	10	¾	3 9/16	2 3/32
65-B	45	..	2.1666	1.0000	6¼	13¼	4¼	5 5/16	1⅞
329-B	45	5	2.1666	1.0000	9	13¾	⅜	6	1 15/16

Threading

As all the tool-slides are not necessary to complete this screw, blocks are inserted in the index-plate, and the second and third slides skipped, bringing the turret around from the first to the fourth position for threading. This procedure saves considerable time, when only one tool is necessary on the tool-slide, with the exception of the die.

The time required for threading depends upon the pitch and length of the thread and on the material being threaded. Brass can be threaded, as a rule, at a speed of from 50 to 60 feet per minute, whereas the surface speed for soft steel should not exceed 30 feet per minute. Assuming in this case that the threading is to be done at 107 revolutions per minute, and figuring on a basis of 15 threads, 15 revolutions must be made to advance the die to the required distance. This will require 30 revolutions when figured on the basis on which the turning and forming is done because, for threading, the spindle is only operated at one-half the speed of that used for turning.

As the cam for operating the slide carrying the opening die should never follow the die up on the work, it is possible to use almost any cam, the one requirement being that the rise or advance per revolution of the work does not exceed the lead of the thread. Cam 122-B, according to Table 1, advances the slide at the rate of 1.817 inch per minute and as the spindle is rotating at 107 revolutions per minute, the advance per revolution is approximately 0.017 inch. As the pitch of the thread is 0.125 inch, the cam will not follow up the die.

TABLE 2. RISE OF STANDARD FORMING AND CUT-OFF CAMS AND ADVANCE OF SLIDE

Cam Number	Total Rise of Cam, Inches	Rise of Cam per Inch Travel of Drum	Advance of Slide per Inch Travel of Drum	Travel of Slide, Inches per Minute
Forming Cams				
502-B, coarse	2.500	¼	5/32	0.3384
501-B, medium	1.500	5/32	3/32	0.2033
503-B, fine	0.750	5/64	1/32	0.0676
Cut-off Cams				
499-B, coarse	2.500	¼	7/32	0.4737
500-B, fine	1.500	5/32	9/64	0.3046

Machinery

Selecting Cutting-off Cam

The cutting-off tool is required to take only a comparatively light cut and hence the coarsest feed-cam will be used. As shown in Table 2, cam 499-B advances the cutting-off slide at the rate of 0.4737 inch per minute, and at 215 revolutions per minute gives a feed per revolution of the work of 0.0022 inch. As the cutting-off tool has to travel approximately 0.520 inch, the number of revolutions required will be 236.

Summary of Operations

As it requires 36 seconds for the camshaft to make one complete revolution on the fast feed, this gives 9 seconds to index from one position to the next, and approximately 1 second to withdraw the plunger, making a total of 10 seconds for indexing. The tool-slides have a total travel of 8½ inches when the standard return cams are used, so it takes 3 seconds for the tool-slides to be returned the full distance. Allowing 3 seconds to feed the stock and close the chuck, the time required to complete the screw can be determined, as the spindle is operating at 215 revolutions per minute, or approximately 3.6 revolutions per second.

Operation	Time, Seconds	Number of Revolutions
Feed stock to stop and chuck	3	10.8
Index turret	10	36.0
Advance turner and turn	127	458.0
Return turner and index two spaces	21	75.6
Thread and withdraw die from work	10	36.0
Cut off and index turret	66	236.0
Withdraw cut-off and feed stock	15	54.0
Total	252	906.4

It is thus found that approximately 4.2 minutes will be required to complete this screw.

Setting Cams and Tools

When setting up the Gridley automatic turret lathe to produce any piece of work, all the cams, dogs, etc., should be set before the tools are set or adjusted. The arrangement of the various cams for producing the hexagon-head screw is shown in Fig. 1. As only two turret-slides are used, the first step is to insert blocks in the turret index slots that will not be used. Then, when the turret is in-

dexed, it jumps from the first to the fourth slide, skipping the second and third. The stop is held on the corner of the turret, and so the next step is to set the cam for the stop. The high point of the stop cam and the high point of the chuck-closing cam should be equal. When roll *B* is on the high point of the chuck-opening cam *D* and roll *G* is on the stock-feed cam 587-B, roll *A* should have a quarter-inch lead on cam 23-B in order to release the chuck. Cam 587-B should be relieved according to the amount that the collet feeds forward when gripping the stock. To return the stock stop, cam 66-B should be set with clearance for the roll to pass between it and cam 587-B. When the roll is flush with the high point of the return cam, the indexing dog should be set on the cam-operating drum against the revolving lever at this point, as shown in Fig. 3. Indexing should be done only on the fast feed. The turret is now indexed to the first slide and the machine stopped at this point. In all the examples given, indexing points are marked *T* and points where changes in speed occur are marked *S* and *F*, which designate slow and fast speeds.

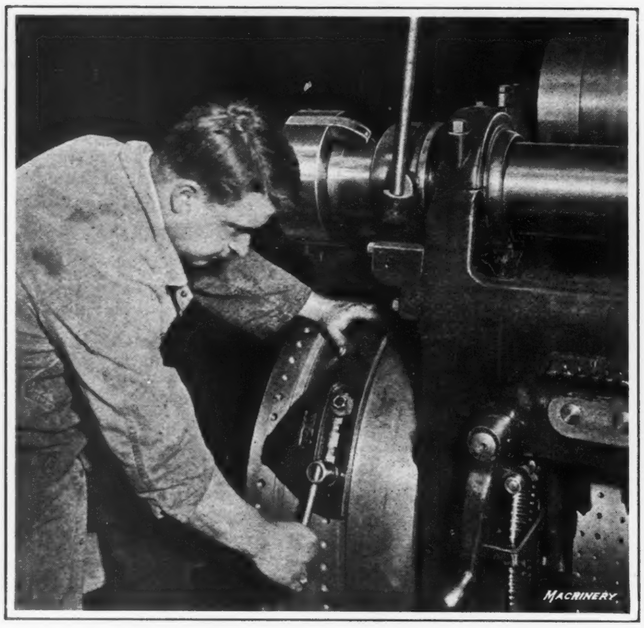


Fig. 2. Clamping Cams on Main Cam-drum

Setting Turret Feed-cam

As the cam to be used for operating the turning tool has been selected, the next step is to clamp this to the drum, as illustrated in Fig. 2. Cam 64-B is now set up against roll *G* and the slow-feed dog, shown in Fig. 4, should be set on the cam-operating drum at this point for safety in setting up the machine; the dog is properly located later. Crank the machine forward, by hand, until the roll *G*, Fig. 1, is at the high point of cam 64-B; then set the forming cam 502-B, which was previously selected for operating the forming slide, at the high point of the roll *H*, allowing clearance for the roll to pass between cams 502-B and 482-B. Also set the fast-feed dog on the operating drum at this point as shown in Fig. 4. Now set the forming slide return cam 482-B and the tool-slide return cam 63-B, allowing clearance for rolls *G* and *H*. Then crank the machine forward until roll *G* is at the high point of the return cam 63-B and set the indexing dog, as shown in Fig. 3, at this point. Index the turret from the first to the fourth position or slide, where the threading is to be accomplished. The die is to be operated at a slower spindle speed than the other tools so that the belt should be shifted from the fast to the slow spindle speed as soon as the drum shaft starts to rotate at the fast feed. As soon as the turret has indexed to the fourth slide, stop the machine and set the roll *G* at the high point of the die cam 122-B. The drum rotates on the fast feed until the die opens. The return cam for the die slide should now be set as shown in Fig. 1; then crank the machine until the roll *G* is on the high point of the cam 63-B, and measure down on the cut-off cam 499-B a distance slightly greater than the amount of travel actually required to cut off the piece. Set roll *J* at this point and clamp cam 499-B in position. Crank the machine, by hand, until roll *J* reaches the high point of the cam and set the cut-off cam 499-B and the return cam 483-B so as to return the cut-off tool clear of the spindle nose when roll *B* is on the high point of the chuck-opening cam *C*. Set the dog on the operating drum to change from slow to fast feed when roll *J* is on the high point of the cut-off cam 499-B; also set the dog to index from the fourth slide to the stop. This completes the rough setting of the cams.

Setting the Tools

Before proceeding to set any of the tools, it is a good plan to give attention to points that have not been mentioned; one is the placing of the weights, see Fig. 5, on the chain that operates the stock-feeding mechanism. The number of weights to use is governed by the weight and size of the bar being handled, so that it is sometimes necessary to add weights after the machine has been set up. Usually, after the operator has had some experience, he can tell how many weights are required without trial.

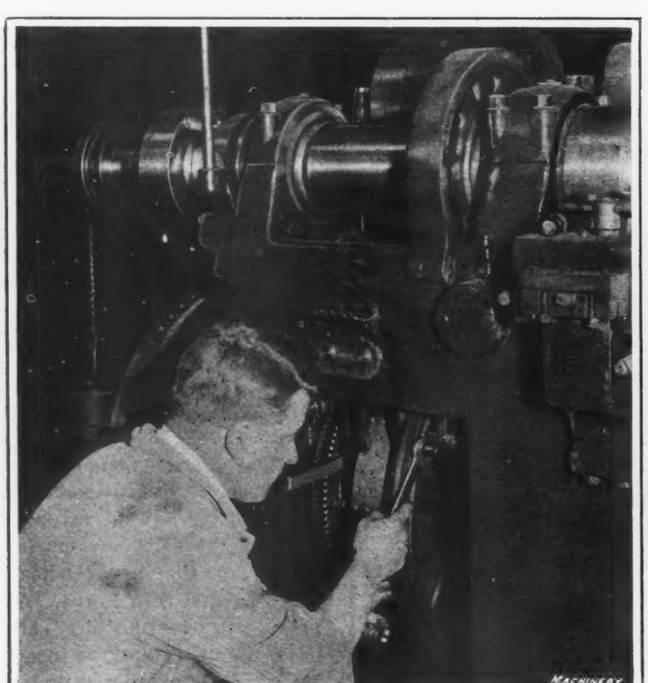


Fig. 3. Adjusting Dog for Indexing Turret

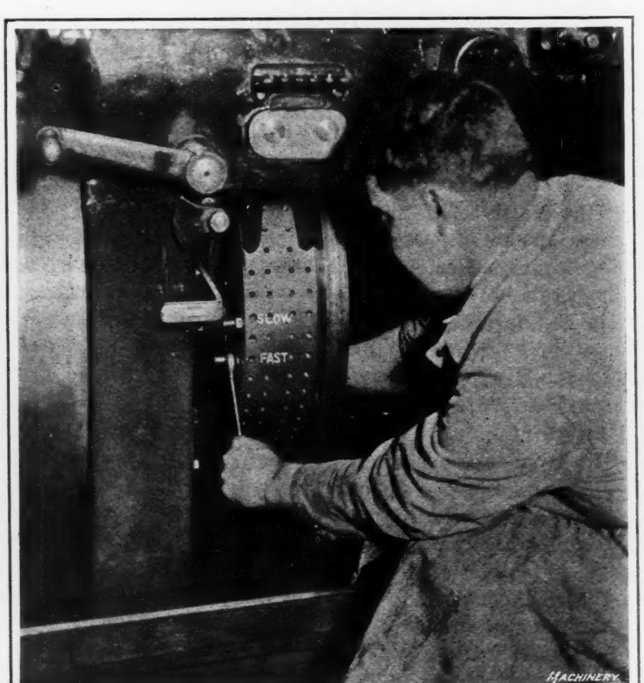


Fig. 4. Adjusting Dog for changing from Slow to Fast Feed

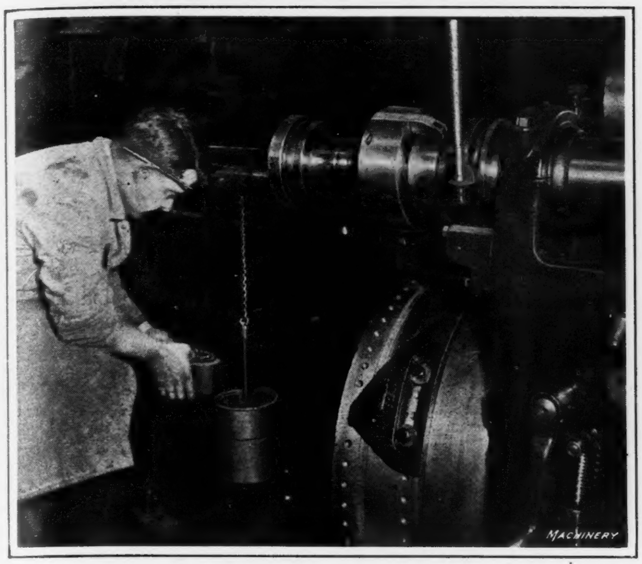


Fig. 5. Changing Weights on Stock-feeding Mechanism

Fig. 6. Adjusting Friction for Fast-feed Pulley

Another point that should receive attention is the setting of the friction on the pulleys that control the operation of the fast and slow feeds of the camshaft; this is set as shown in Fig. 6. The set-screw is released and the plunger forced down by hand sufficiently to exert the required friction on the pulley, after which the set-screw is tightened. If this friction is not tight, and the tools are set close to the work before changing to the slow feed, a slight slippage of the belt is likely to cause the tools to dig into the work, with the result that they may be broken. Many operators do not give this friction any attention until they experience trouble; it should be adjusted each time the machine is set up, and on a long run of work, it should be frequently inspected.

Setting the Stop

The first tool to set is the stop; as a general rule, the corner stop is used. The machine is cranked by hand until the roll is at the high point of the stop cam 587-B, Fig. 1; then the stop is placed in position on the corner of the turret and moved into the approximate position. A scale is used to measure from the face of the chuck, as shown in Fig. 7, allowance being made for clearance for the forming and cutting-off tools and for the thickness of the cutting-off tool. When the stop has once been properly set, it is clamped in position. The stop cam should be relieved according to the amount that the collet feeds forward when gripping the stock. This relieves the pressure of the stock on the stop caused by the chuck closing on the work. Then the return cam should be set for the stop, so as to come into action just as the roll leaves the high point of the cam that advances it. The draw-bar roll at this time should be flush with the high point of the stop return cam. Now the dog on the operating drum, Fig. 3, should be brought up to the lock-pull lever and the machine indexed by power on the fast feed of the camshaft by setting the dog for shifting the belt on the pulleys shown in Fig. 6. The belt shifter should be so set that it throws the belt over the full distance and does not allow it to drag on the slow-feed pulley; then, as the lock-bolt drops into place, the machine should be stopped by pulling over the belt shifter by hand and the dog placed for shifting to the slow feed at this point.

Setting Forming Tool and Turner

As the forming cam has been set in position, the next step is to set the forming tool to the spindle nose, and not for turning to the correct diameter. The forming tool to use is clamped in the proper holder, and the latter located on the forming slide, as shown in Fig. 8, by means of a scale, measuring from the face of the chuck to the rear of the forming tool. In setting this tool, it is necessary to take into consideration the amount that was allowed for clearance and, in some cases, the amount used up by the tool in cutting off the piece from the bar. Then set the turning tool relative to the face of the chuck, as shown in Fig. 9. In this particular case a single turner is being used, which is placed on the first slide and moved into the approximate position; then, by means of a scale, measure from the face of the chuck to the front edge of the turning tool, making allowance for clearance for the forming tool and the distance that the turning tool has to travel on the work.

The next step is to set the turning tool to approximately the correct diameter. First open the chuck by hand and insert a bar of stock, letting it project from the face of the chuck the required distance. Then close the chuck by hand and pull over the belt shifter to start the spindle rotating. Before starting to turn the crank handle, release the roller-rests and withdraw them so that they will not come into

Fig. 7. Setting Corner Stop Relative to Spindle Nose

Fig. 8. Setting Forming Tool Relative to Spindle Nose

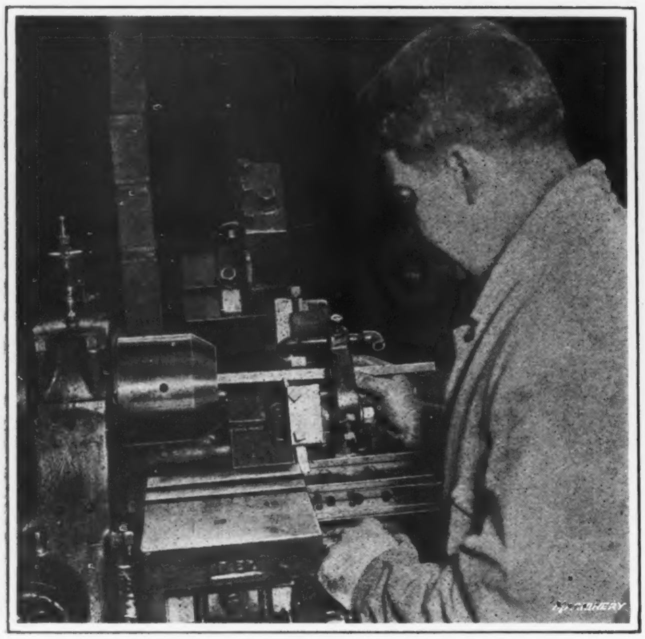


Fig. 9. Setting Turning Tool Relative to Spindle Nose

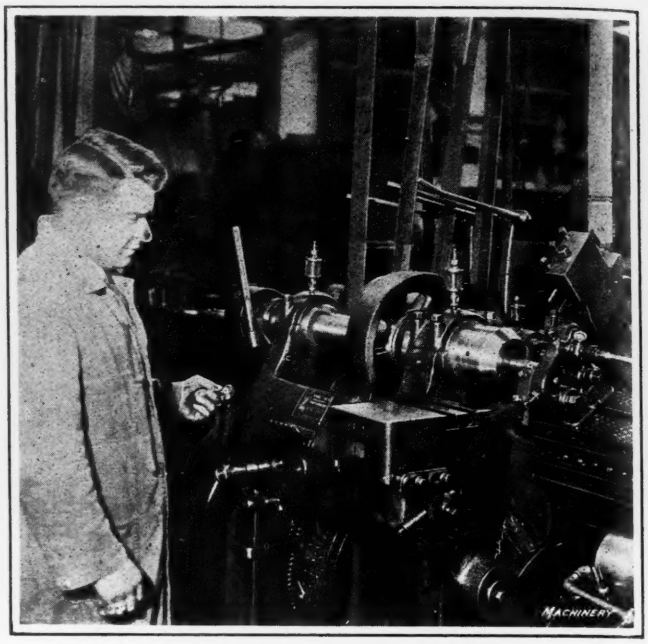


Fig. 10. Setting Turning Tool to partly turned down Work

contact with the work. Then set the turning tool to approximately the center of the bar, clamp the holder and the tool in position, and turn the bar down for a distance of about 1/4 inch, cranking the machine by hand. Now stop the spindle and measure the work; if it is not correct, crank the machine backward until the tool is free from the work and adjust it. Continue in this manner until the tool has been properly set. Then, with the tool still in contact with the work and the spindle stopped, set the roller-supports to the work. Crank the machine by hand, see Fig. 10, until the roll is at the high point of the cam and the tool set so that it will turn to the required length.

Before setting the dog to shift to the fast feed, set the forming tool in the correct position and adjust the forming cam, if necessary, so that the roll is at the high point of the cam when the forming tool just clears the work. Start the spindle rotating and feed in the forming tool, by operating the screw that adjusts the slide, until the forming tool has turned the bar down to the correct diameter. Then set and lock the stop in the forming slide, so that the forming tool will always advance to the same position. It is a good idea to put a slight spring or tension in the lever operating the forming slide, so that the forming tool will finish up with a light cut. Set the dog to shift to the fast feed on the high point of the cam, and set the return cams, 63-B and 482-B, if necessary, leaving sufficient space for the rollers to pass between them and the advancing cams. Clamp the cams in position and crank the machine until the roll is on the high point of the return cam 63-B. Then set the dog as required for indexing the turret.

Setting Die and Die-operating Attachment

As soon as the turret has been indexed to the point where the fourth slide is in line with the chuck, stop the machine and set the die attachment. Rotate by the hand-crank until the roll is on the high point of the threading cam 122-B. Then move the die attachment up on the slide, bringing the die up against the end of the work. Exert pressure on the die-holder to compress the spring, Fig. 11, and at the same time tighten the screws that clamp the die attachment to the slide. Set the cams to shift the belt from the fast to the slow or threading spindle speed. This cam should be set so that the belt is shifted before the roll reaches the high point of the threading cam. The dog for shifting from the fast to the slow feed is not set, as the screw is threaded on the fast feed.

After the tension on the die has been set with the die closed, open the die and move it out of the holder to the desired distance for the length of thread. If threading to a shoulder, set the die 1/16 inch away from the shoulder. Place the stop on the corner of the turret-slide, as shown in Fig. 12, so that the die will be opened at this point, and later adjust the stop so that the die is advanced to the exact position before opening. Crank the machine backward so that the roll is free from the die cam, and adjust the screws in the stop on the corner of the turret, as shown in Fig. 13, to close the die when it returns. Then bring the die forward by cranking the machine and note that the spindle shifts from the fast to the slow spindle speed before the die comes into contact with the work. Allow the die to thread or advance on the work by power until the die is opened; then place the return cam one inch from the roll, placing the high-speed cams so as to shift

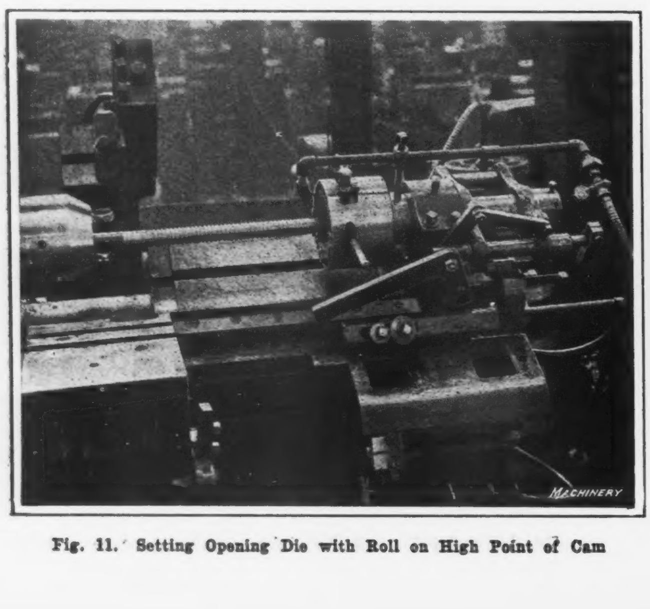


Fig. 11. Setting Opening Die with Roll on High Point of Cam

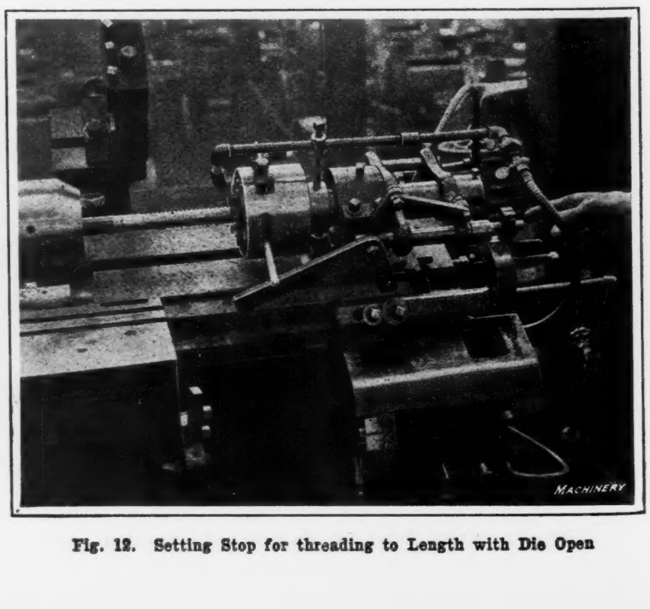


Fig. 12. Setting Stop for threading to Length with Die Open

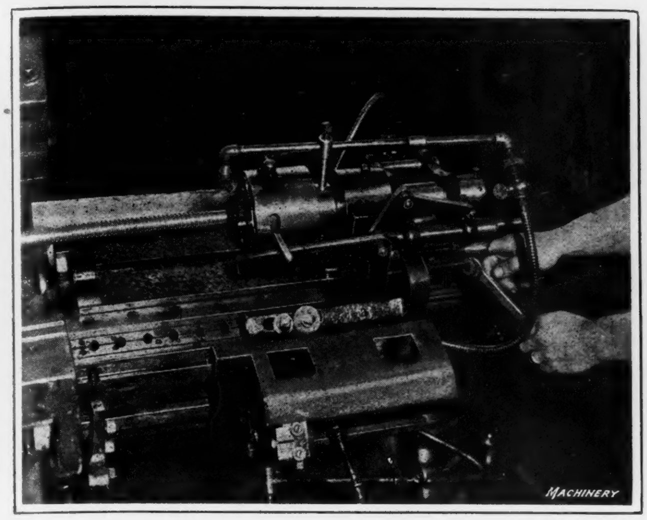


Fig. 13. Setting Stop for closing Die

Fig. 14. Setting Die for Size to Plug Gage

the machine to the fast spindle speed. This completes the setting of the die attachment; and in order to set the die so that it will cut a thread of the correct diameter, it is advisable to set the chasers to a plug gage, as shown in Fig. 14. The die is closed by operating the closing lever and then the chasers are adjusted to the plug gage.

Setting Cut-off Tool

Now set the cut-off cam 499-B, Fig. 1, as shown in Fig. 15, so that the cut-off tool will start to work by the time the spindles have changed to the fast speed. This cam should be set so that when the spindle is changed to the fast speed, the roll will be on a point of the cam that measures an amount equal to the distance that the slide has to travel from the high point of the cam to cut off the piece. It is generally advisable to measure this distance with a scale and scribe a mark to which the roll should be set.

The chuck can now be opened (if the cut-off tool has not previously been set), the bar pulled back, and the cut-off tool set relative to the center of the chuck, as shown in Fig. 16. To do this, it is necessary to crank the machine by hand until the roll is on the high point of the cut-off cam; then set the cut-off tool and clamp it in position. Now crank the machine back to the point where it will start to cut off, push out the stock, set it, and close the chuck; set the slow-feed dog at this point. The piece is now cut off by cranking the machine by hand, and, as the tool passes the center, set the dog to shift to the fast feed; also, set the dog to index from the die slide to the stop. Set the return cam 483-B, Fig. 1, to return the cut-off slide, leaving space for the roll to pass between the two cams. Leave the machine running on the fast feed until the first tool is in position to start on the work; then set the slow-feed dog. This completes the setting up of the machine, cams, etc., but in some cases it may be necessary to make a few minor adjustments when the tools are working.

The second installment of this article, to be published in the July number, will deal with specific tooling lay-outs, and will conclude the series of articles dealing with the operation of Gridley automatic machines.

* * *

ROCHESTER'S DEPARTURE IN MECHANICAL EDUCATION

An interesting departure in mechanical and engineering training has been made by the Rochester Athenæum and Mechanics Institute, where two-year courses have been instituted along the lines of mechanical, electrical, and chemical engineering. The object of these courses is to provide a thorough specialized training to fit men for supervisory positions in the industries. The courses will train men for the responsibilities of engineering work in industrial plants and for shop superintendents and factory management. The object is to train young men who have shown progress in mechanical work but who have not had the advantage of a complete high-school education, and who, for that reason, are unable to go to a regular engineering college. In the courses, special emphasis is laid upon designing for the machinery trade and upon shop methods for production, without entering into the purely theoretical side of engineering problems, except in so far as the theory is required for the solution of the practical problems met with throughout the courses. As experience is gained, it is likely that similar courses will be instituted elsewhere in manufacturing centers, and that the courses inaugurated by the Rochester Athenæum and Mechanics Institute will prove to be of pioneer value in the solution of a problem of mechanical education that has been found puzzling in the past.

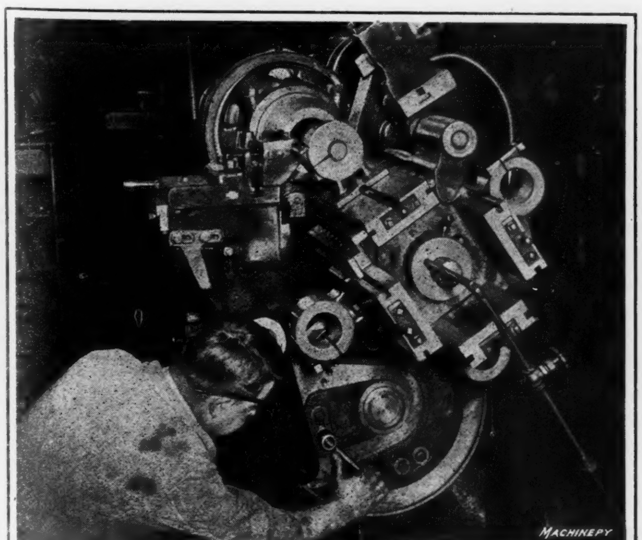


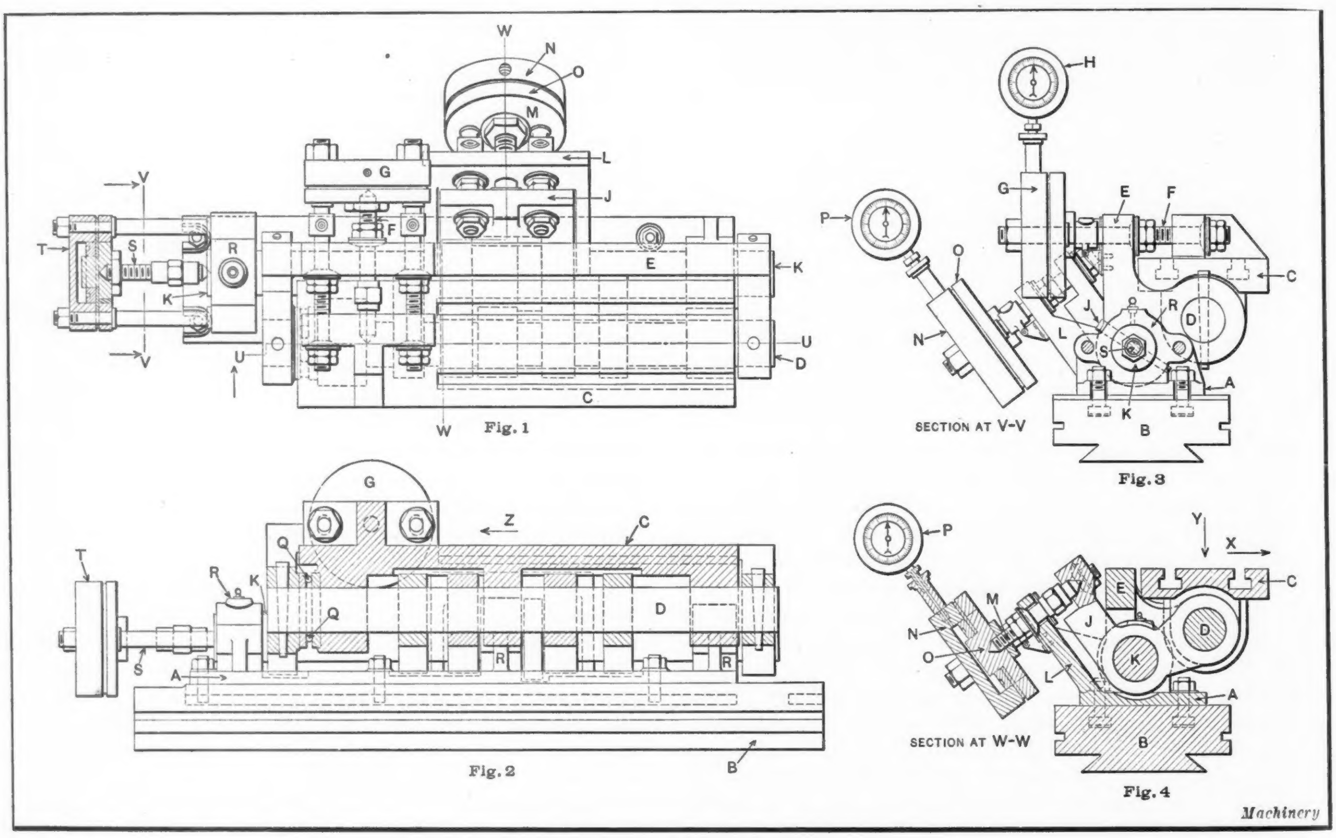
Fig. 15. Setting Cams on Forming and Cut-off Drum

Fig. 16. Setting Cut-off Arm and Tool

UNIVERSAL MILLING MACHINE DYNAMOMETER

BY R. POLIAKOFF[1]

The dynamometer shown in the accompanying illustration was designed for measuring the pressure that a milling machine cutter exerts on the work and on the various parts of the milling machine through the work. The purpose of ascertaining these pressures is to determine the strength required of the different parts of the milling machine or the cutter itself; incidentally it also affords a means of determining the causes of unsatisfactory finish on the surfaces machined, discrepancies in dimensions, etc. This dynamometer is termed "universal" because it determines the pressure exerted by a cutter of any type and size within its capacity. Fig. 1 is a top plan view of the dynamometer. Fig. 2 is a vertical sectional view on line U–U, Fig. 1. Fig. 3 is a cross-section on line V–V, Fig. 1, and Fig. 4 is another cross-sectional view on line W–W, Fig. 1.



Figs. 1 to 4. Universal Milling Machine Dynamometer

The dynamometer is supported on the foundation plate *A* as shown in Fig. 4, and is held in place on the table *B* by T-head bolts. The work is placed on the auxiliary table *C* of the dynamometer and securely fastened by bolts. The milling cutter is then brought into contact with the work. The resultant pressure exerted upon table *C* through the work may be resolved into three components, each component being at right angles to the other. The horizontal arrow *X* pointing in the right-hand direction indicates the direction of one of these components, and the vertical arrow *Y* pointing downward through the table *C* indicates the second component. The direction of the third component is designated by the arrow *Z* in Fig. 2, which points in the left-hand direction. The pressure imposed by the cutting tool on the work may thus be divided into its three components by the dynamometer, and the amount of pressure in each component direction is registered on separate gages, so that it may be quickly and accurately determined. The strength required of all parts of the milling machine can therefore be checked accordingly.

The pressure exerted in the direction of the arrow *X*, Fig. 4, will tend to rock the table *C* in a clockwise direction about the shaft *D*, without affecting the carriage *E*. In executing this movement, table *C* will draw the rod *F*, Fig. 3, to the right. This exerts a pressure on the gage box *G* in a manner which causes the liquid contained in it to be driven up through the connection into the dial *H* in an amount proportionate to the amount of pressure exerted. The hand of dial *H* will consequently be moved to a corresponding extent to indicate the degree of this pressure. Referring to the component exerted by the cutting tool on the work in the direction of arrow *Y*, Fig. 4, the pressure exerted on the table through the work will cause the table to descend, rocking plate *J* about shaft *K*. As plate *J* is moved away from arm *L*, rod *M* will cause a compression of the gage box *N* and the amount of pressure will be indicated by the position of the hand of dial *P*.

The pressure exerted in the direction of the arrow *Z*, Fig. 2, will force the table *C* in a longitudinal direction. This longitudinal movement will be communicated to carriage *E*, Fig. 4, through thrust bearing *Q*, Fig. 2, and, in turn, by reason of the connection with shaft *K*, carriage *E* will cause shaft *K* to move in a longitudinal direction in bearing *R*, which is part of the foundation plate *A*. When so moved, shaft *K* exerts a pressure on gage box *T* through spindle *S*. This pressure is recorded by a gage attached to gage box *T*.

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* * *

PROTECTION OF TRADEMARKS ABROAD

Since the outbreak of the war, American manufacturers have been constantly urged to take advantage of the trade opportunities awaiting them in foreign fields. In very few cases, however, has the subject of trademark registration been presented to them. This registration, however, is most necessary to the opening of business relations in any country, for in some cases the legitimate owners of trademarks have been unable to sell their goods in certain countries because some pirate has forestalled them in the registration of their mark. The statutes of many countries provide that the first person to register a trademark is entitled to the exclusive use thereof, regardless of whether or not he is the originator and actual owner of the mark.

* * *

Last year, this country's imports from South America amounted to $598,000,000, an increase of $151,000,000 over the year before; it exported to South America $312,000,000 worth of goods, an increase of $90,000,000.

LETTERS ON PRACTICAL SUBJECTS

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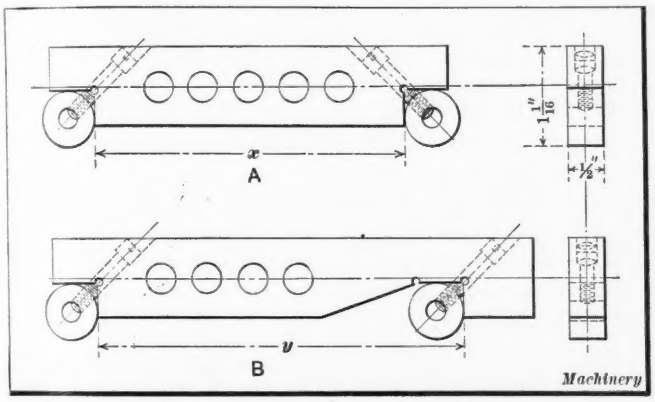
SINE BARS OF IMPROVED DESIGN

The improvement in the sine bars to be described is in the method of locating and fastening the disks or buttons to the bar. The bar illustrated at *A* has an over-all length of 5½ inches with a center-to-center distance between the disks of 5 inches. As these disks are 0.750 inch in diameter, the distance *x* between the shoulders of the bar is 4¼ inches. The bar illustrated at *B* also has a center-to-center distance of 5 inches between the disks, which corresponds to the distance *y*. This bar has the advantage over the other one in that more acute angles can be obtained and it is also a fool-proof design on account of the arrangement of the faces or shoulders against which the disks are held. For instance, if too much material is ground from the right-hand surface, it is simply necessary to regrind the surface or shoulder at the left in order to obtain the correct distance *y*.



Sine Bars having Shoulders against which Disks are held by Screws placed at an Angle of 45 Degrees

These bars and disks are hardened and ground, and the disks are lapped to size. As the illustration shows, the disks are secured to the bars with fillister-head screws (No. 12), which pass through holes drilled at an angle of 45 degrees so that the disks will be drawn against both the horizontal and vertical surfaces at the ends of the bars.

New Britain, Conn. William C. Betz

MAKING AIR-RIFLE TRIGGER GUARD

The accompanying illustrations show the trigger guard of an air-gun, and the die for giving it the second and final form. In Fig. 1, *A* is the finished guard and *B* is the guard when it is ready for the second die. At *A*, Fig. 2, is shown a plan of the die with the levers, or jaws, closed, and at *B* is shown the die with the jaws open to receive the work. At *A*, Fig. 3, is shown a side view of the left operating pin, with the collars and the lay-out of centers for turning it, together with a partial view of the shoe and the punch-holder. The front view of the pin is shown at *B*. The letters *T*, *L*, and *R* refer to similar points on the pins shown in Fig. 2.

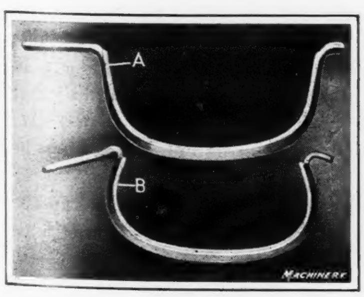


Fig. 1. Air-rifle Trigger Guard

The dies for the first two operations on the guard are not shown. The first is a simple blanking die for making a flat blank from a strip of round-edge flat wire, cutting at the ends only, and the second is a simple U-forming die. The final shape necessitates the use of a collapsible inner form, and the die shown was designed as being the easiest to make and operate.

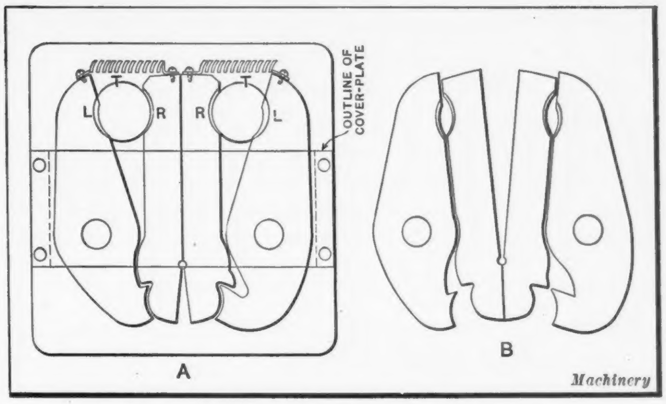


Fig. 2. Last Die used for forming Trigger Guard

It consists practically of two pairs of heavy pliers laid flat on the bed of the die and operated together by two round tapered pins set into a punch-holder, which is not shown. As shown in Fig. 3, the taper on one side of the pins is short and steep. These tapers operate against the inner levers and force them to take their closed position first without any resistance; they are held closed by the straight sides of the pins. The outer levers are operated by the long easy tapers of the pins.

It is necessary to use round pins, because the paths of the levers are arcs and the points of contact travel around the pins. Round pins are, of course, much more difficult to lay out than an ordinary flat wedge, but they were carefully figured and laid out on the drawing-board. The inner levers were set together on a faceplate and bored, as they are straight except for a beveled corner, which was filed. All the work they do is, of course, in a straight line. The outer levers were laid out on each side from the drawing and filed. The cross-section of the levers and their relation to the pins is shown in Fig. 3.

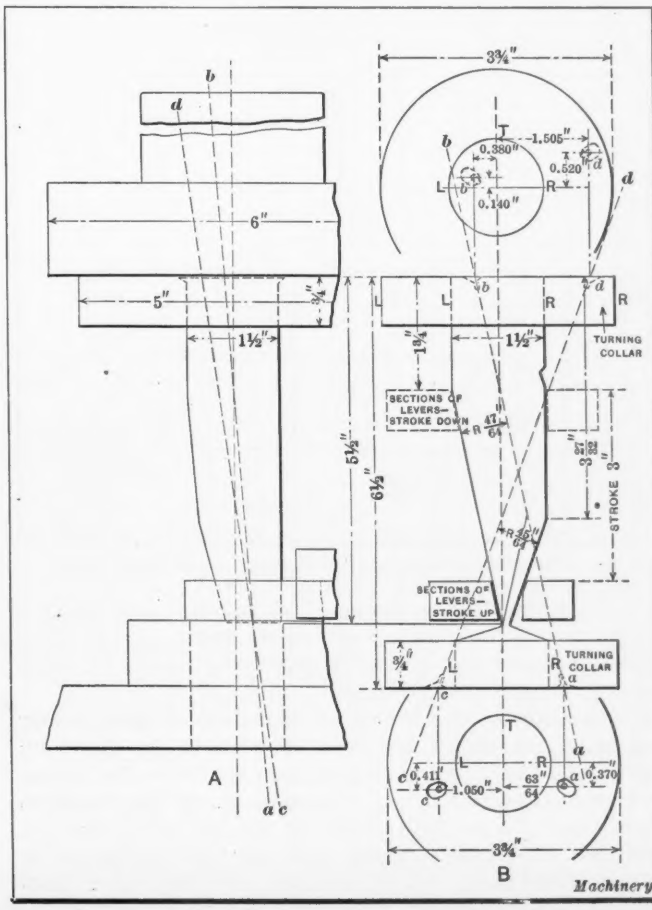


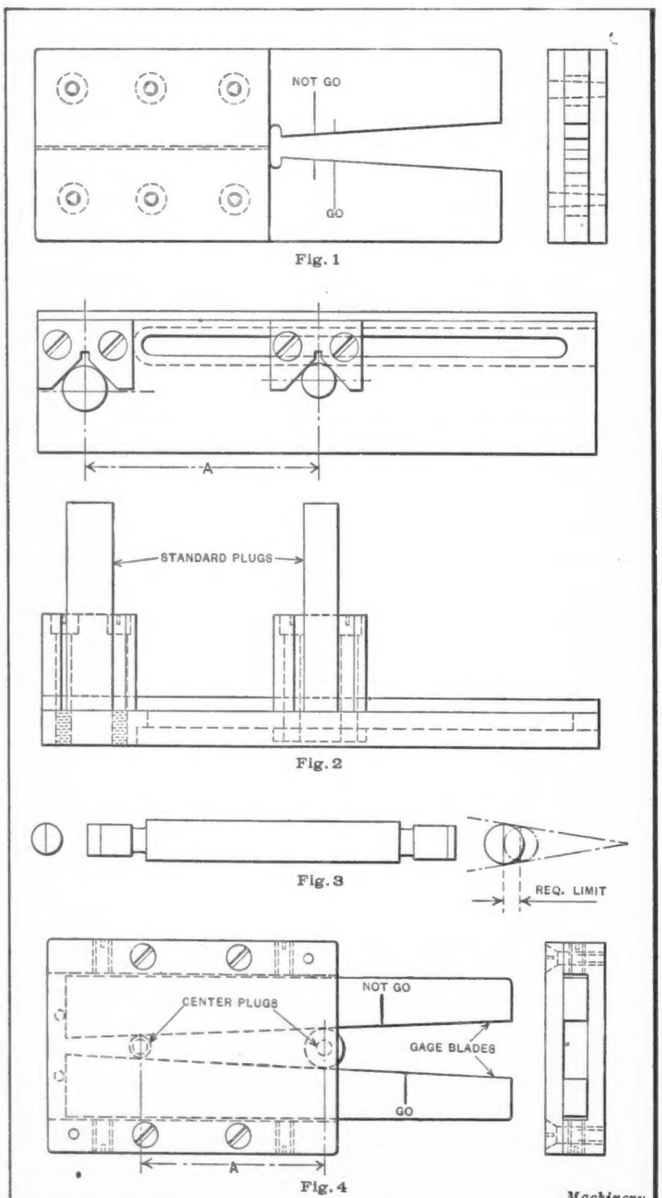
Fig. 3. One of the Operating Pins with Collars and Lay-out for Turning

The levers are covered on the inside faces by a piece of 1/2- by 3-inch steel, held by screws at each end. The outer levers swing on hardened 3/4-inch pins, which are flush with the top of the cover-plate and extend down into the casting base for an inch. The inner levers swing on a small loose pin between them, and are held in position by bearing on the outer levers and the driving pins.

Plymouth, Mich. W. B. GREENLEAF

TAPER GAGES AND GAGING

The making of taper gages is what toolmakers call a "tough job," and experience has shown that even skilled men do not get satisfactory results, compared with the price of the gage. The general way of making these gages is to machine a tool-steel blank until there is just enough material left for grinding and lapping after hardening. The degree of skill required and the trouble that develops are widely known, and probably about 50 per cent of the finished gages, when tested for hardness, will be subject to rejection.



Figs. 1 to 4. Taper Gages and Devices used in assembling them

How this trouble may be avoided by making the gage in four parts—two gage-plates and two cover-plates—is shown in Fig. 1. The machining is an easy matter. Before hardening, the gage is assembled just as if finished, except that the holes for the taper pins are not reamed, but are just drilled straight. After that, the gages are taken apart and holes are drilled in the gage-plates large enough to insert soft plugs after hardening. The rest is simple: hardening, grinding, lapping only straight surfaces, and assembling. The taper pins are riveted over slightly on the small end and secure the parts in position. To assemble these gages with accuracy, the attachment shown in Fig. 2 is used. Standard plugs are employed and the distance *A* is determined with the help of shop trigonometry.

A limit taper gage may be easily made by etching two lines across the gage, as shown in Fig. 1. The positions of these lines are determined with the help of a limit plug, shown in Fig. 3. The two diameters of the plug must, of course, correspond with the required limit of the finished part. It is only necessary to etch the lines exactly over the center of these plugs, for the distance between the lines will give the limit. This plan will render unnecessary the making of a double-end gage and also will save 50 per cent of the time when inspecting the work.

Fig. 4 shows a more costly design, which in the long run will be more economical, particularly when the amount of wear on the gage is taken into consideration. When it is once made, all that needs to be done when the surfaces are worn is to take out the gage blades, regrind or relap them, and put them back into place; no adjusting or inspecting will be necessary. Last but not least, it is the only gage that it is possible to inspect directly with the micrometer and be sure it is right. This type also can be used as a straight gage if the two center plugs are of the same diameter.

New York City MAX T. VOIGT

SALVAGE OF WORN GAGES BY ELECTROPLATING

Methods of making worn thread gages, plug gages, etc. larger or smaller, as the case may be, are of considerable importance to every manufacturer. Many of these expensive tools can easily be saved by plating on them a film of hard, close-grained nickel and then lapping the gages to size.

In depositing nickel on gages, it is necessary to remove all grease due to handling, as the bath used is very nearly neutral. This may be done by placing the gages, for fifteen minutes, in a bath, consisting of eight ounces of caustic potash to two gallons of very hot water; this bath should be renewed quite often if many gages are to be plated. When removed from the bath, the gages should be thoroughly scrubbed with pumice stone and water, rinsed, and then placed in a bath consisting of eight ounces of hydrochloric acid to one gallon of water; this bath is used cold. Fifteen to thirty minutes immersion will remove any oxide that may have formed. The gages should then be thoroughly rinsed, and dried without touching them with the hands, so that greasy spots will not be made on them.

The plating bath is made of twelve to fourteen ounces double sulphate of nickel and ammonia (pure) per gallon of bath, distilled water being used. The nickel salts are put in a wooden tank and dissolved by pouring hot water on them and stirring with a clean wooden stick. After the salts are completely dissolved, cold water is added to bring the solution to the right proportion. Common table salt is then added to decrease the resistance. The bath should be a little bit acid, as it makes the nickel somewhat harder; the acidity of the bath can be tested with a piece of litmus paper. The anode should be made of pure cast nickel as it gives better satisfaction than rolled nickel. The surface of the gages should be calculated and the same amount of anode surface exposed.

The current used should be regulated very carefully, as the results are highly dependent on this. The plating should be begun with a current of 9 to 10 amperes per hundred square inches of plating surface and be reduced after the deposit starts to from 0.75 to 1.25 ampere. The voltage used depends somewhat on circumstances, but should begin at 5 volts and be diminished to from 1.5 to 2 volts. The amount of metal deposited on the gages may be determined by the use of a pair of micrometers in the case of plug gages. With thread gages, a piece of steel stock of known size may be immersed in the bath and measured to determine the amount of metal deposited on the threads.

A great many manufacturers have outfits for plating small parts that they manufacture. A little cooperation between the

tool-room and the plating room will be a source of considerable profit. A boy can do all the operations involved if the directions given are carefully followed. That the tools do not have to be annealed is an advantage that every toolmaker can appreciate.

Jackson, Mich. RICHARD GIBBS

COOPERATION WITH THE TOOL ENGINEER

The editorial in the February number of MACHINERY entitled "Cooperation with the Tool Engineer" does not go far enough; in addition to the tool engineer, the designer should consult with the shop superintendent and the foreman of the department in which the machine is to be used. Too often, the man who makes the design is looked on as a necessary evil, and some shops have tried to do away with him. This, no doubt, accounts for the crude designs, called "machine tools," that are to be seen in some shops. One of these, a one-purpose lathe, was so constructed that the gears were enclosed by the head casting and the only way in which speed changes could be made was by having the operator get under the machine and reach through the bed. Needless to say, the operator avoided changing the speeds as much as possible and the best results were seldom obtained.

One reason why many machine tools are not well designed is that the designer does not come into contact with the shop as much as he should. Of course, some draftsmen think that it is unnecessary for them to mingle with the men who wear overalls. On the other hand, many firms have the idea that the time spent by a designer in the shop is wasted. They think that he should spend all his time working at the board, and fail to recognize the value of information he obtains by seeking the criticisms of the men who operate the machines. By obtaining these criticisms, he is able to improve the machines or the designs of new ones.

If a new design is submitted for criticism to the tool engineer, superintendent, and the foreman of the department in which it will be used, any faults of construction or operation it may contain will be found, and it is much easier to correct these on the drawings than after the machine is made. However, such criticisms should be made in a spirit of cooperation rather than through a desire to find something wrong. By having these men discuss the designs with the designer, the latter gradually absorbs ideas from the other men and his vision is broadened. Besides, much of the fault finding now prevalent will be done away with; it will be impossible for the foreman to say, whenever a machine proves faulty, "If my opinion had been asked I could have prevented that mistake." Having attended the conference at which the design was discussed, the superintendent and foreman will be better satisfied with the tools given them, and the designers will become more capable and better pleased with their product. In addition, the method of finding in the shop any mistakes the design may contain is avoided.

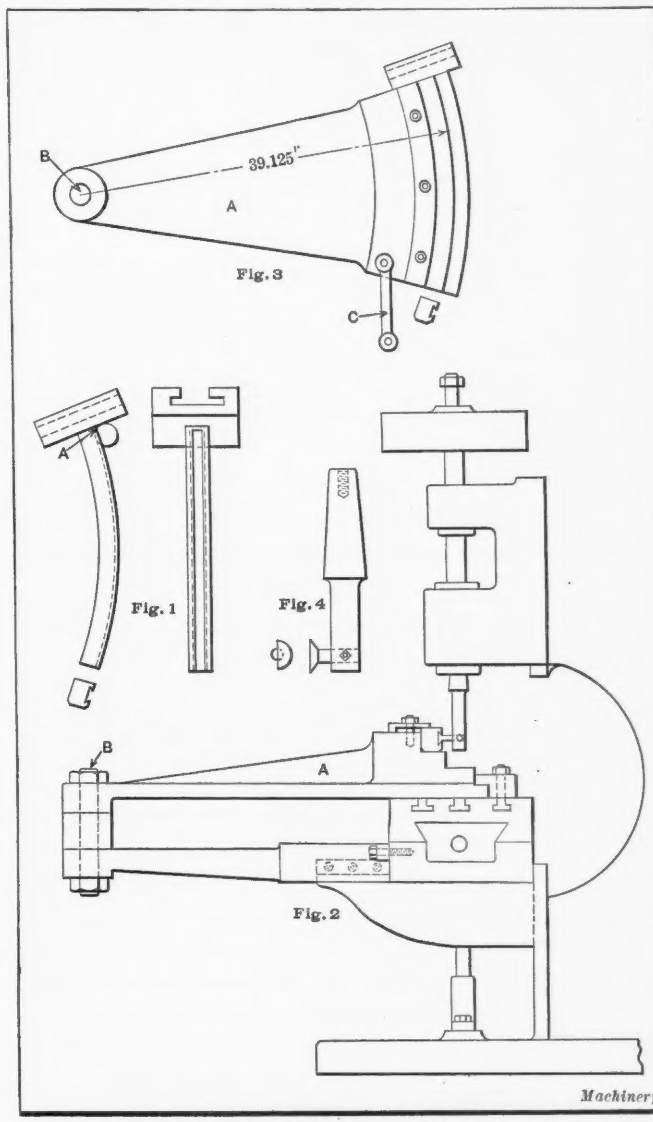
Providence, R. I. ROBERT MAWSON

CUTTING A DOVETAIL SLOT IN A GUN SIGHT

A shop doing munition work found it necessary to cut a dovetail slot for the graduated German silver scale in a radial sword arm for a five-inch gun sight. This slot is 0.125 inch deep, has a maximum width of 0.75 inch, and its sides are at an angle of 55 degrees and must be parallel, with only 0.001 inch tolerance in the full length of the sword arm, which is 26 inches. The radius is 39.125 inches to the outside diameter. As shown in Fig. 1, the slot must be carried close up to the head of the sword arm. In order to produce an interchangeable job, precision and accuracy are required; also an extremely smooth surface is necessary, for chatter marks are rejected. The work cannot be done on a planer because there is no clearance for the tool and it is impossible to shift the stroke to exactly the same position each time; furthermore, it is necessary to have complete control of the speed at all times.

After considering several methods, it was decided to plane the slot on a vertical milling machine, as shown in Fig. 2. The operator attends to the tool, feed, etc. while a helper moves the table back and forth by means of the rapid traverse handle, which is not laborious work. When the table is moved, it causes the plate *A* to rotate on its bearing *B*, as the plate and the table are connected to each other by a link *C*, Fig. 3. The bracket for the sword arm is also milled in this fixture.

First of all, a slot is cut in the center of the arm by a regular flat milling cutter mounted on a screw arbor, using the regular machine feed, etc. This, however, leaves some stock *A*, Fig. 1, at the head end, so the bar is removed, gripped in a milling machine vise, the head end squared, and this part of the slot is dovetailed with a small mill. Although this is straight milling and not radial, the difference is so slight that it is not noticeable; besides a clearance space is provided for the dove-



Figs. 1 to 4. Gun Sight in which Dovetail Slot is cut and Arrangement for cutting Slot

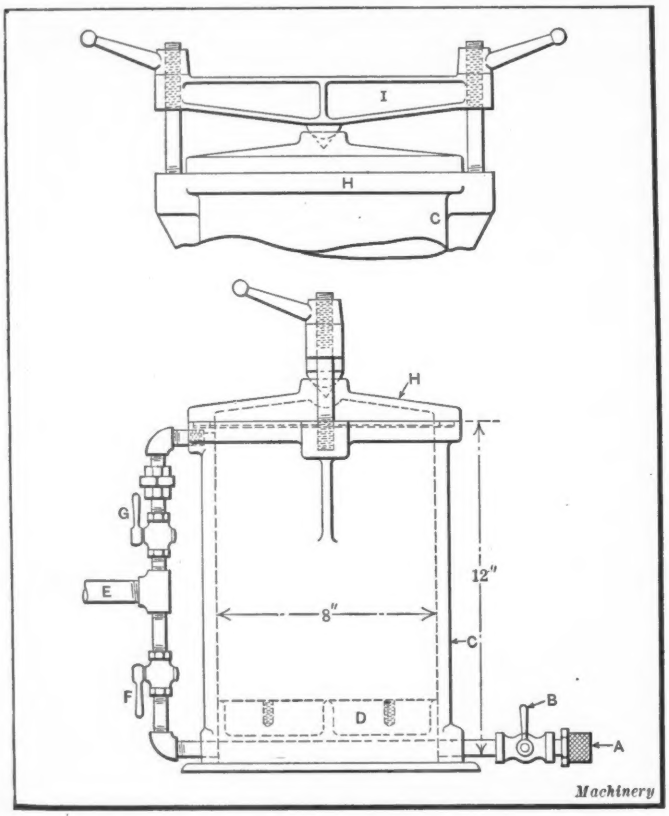
tailing planer tool. The space is so small, however, that no planer, nor any other tool that is not absolutely under control, will reverse in it. By moving the table by hand, the operator is able to reduce the speed as the end of the slot is reached and thus cut very slowly into the clearance space. A stop is also placed on the ways to limit the table movement. After the slot is milled in the arm and the head end is dovetailed, the bar is returned to the fixture, the spindle is locked by inserting the back-gear without the spring pin, and the slot is finished by means of the planing tool shown in Fig. 4. This tool is held in a special arbor, which can be made at a very small cost.

Baltimore, Md. RAYMOND H. DAUTERICH

DEVICE FOR FILLING GREASE CUPS

The usual method of filling grease cups before they are placed on the bearings is to unscrew the cup, pack the grease in it with a paddle, and then screw the cup on the retainer, which takes about one or two minutes' time. But with the

device here shown the cups may be filled within a few seconds. It is only necessary to insert the threaded end of the grease cup in nozzle *A* and turn the lever *B* to fill the cup instantly. If desired, a spring may be attached to lever *B* and to the body of the device and a foot-lever attached to the valve-lever



Device for filling Grease Cups

B. As the device may then be operated by foot, the operator will be able to use both hands for handling the cups.

The device consists of a cast-iron cylinder *C*, a piston *D*, and the necessary connections to the compressed air line *E*. To operate, the lower air valve *F* is turned downward and air is admitted below the piston *D*; this raises the piston to the top of the cylinder so that it can be removed and then the air is shut off. After the cylinder is filled with grease, the piston *D* and cover *H* are put in place and lever *G* is turned so that compressed air is admitted to the top of the piston. Then when a grease cup is inserted in the nozzle *A* and lever *B* is turned, the compressed air forces the grease into the cup. The cover *H* is held in place by the bronze casting *I*, which has a ball joint that fits into the top of the cover, making a flexible but secure joint.

Flint, Mich. C. C. SPREEN

INDEXING ATTACHMENT

In Fig. 1 is shown an indexing attachment that may be easily adapted to a number of purposes. It was designed for making the saddle slide of an ordinary engine lathe, shown in Fig. 2, which requires the operations of facing the surface *A*, turning, boring a hole *B* in the center, cutting T-slots, and graduating. With this attachment, all these operations can

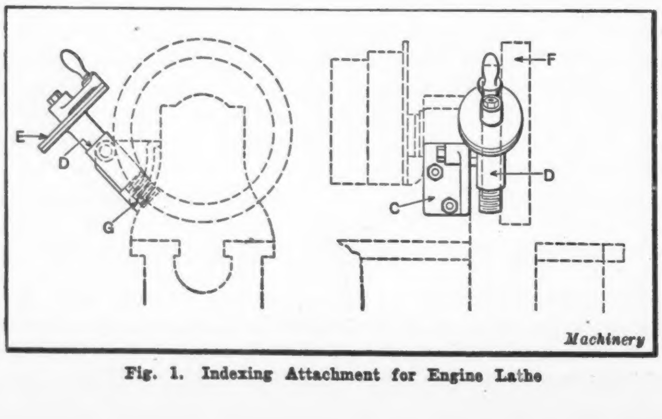


Fig. 1. Indexing Attachment for Engine Lathe

be done at one setting of the piece in the chuck.

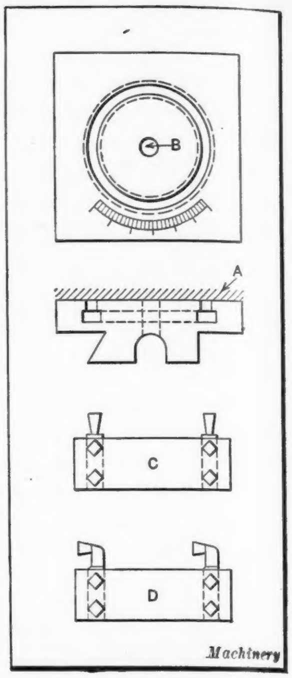


Fig. 2. Work for which Attachment was designed and Tools used

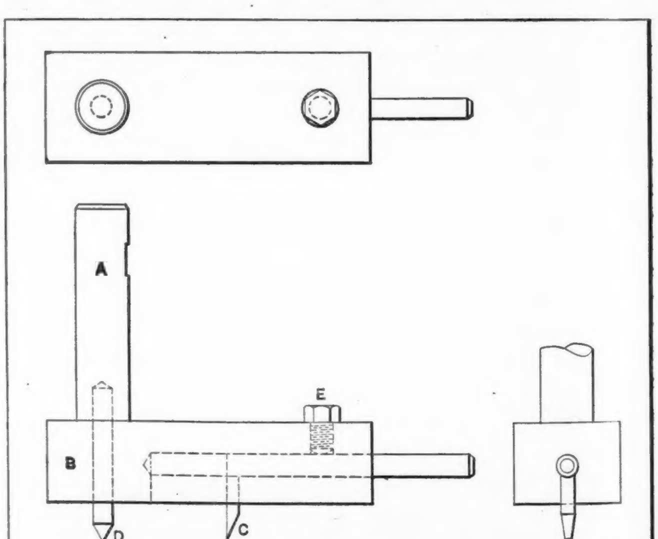
The main bracket *C*, Fig. 1, of the attachment is fastened to the side of the lathe headstock, as shown, and the bracket *D* carrying the worm-shaft and supporting the dividing plate bearer *E* is swiveled on a stud in the bracket *C*. A worm-wheel mounted at the rear of the chuck *F* allows the worm *G* to engage with it. It is not necessary to detach this arrangement for ordinary use, as the bracket *D* carrying the worm *G* can be swung clear of the worm-wheel so as to leave the lathe free to be used for ordinary work.

To do the particular job shown, a six-side turret was employed. One side carried a turning tool for facing the surface *A*; the next side carried a drill for hole *B*; the third side carried a reamer for hole *B*; the fourth side carried a bar with the tools shown at *C*, Fig. 2; the fifth side carried a bar with the tools shown at *D*; and the sixth side carried the marking tool for indexing. By using this attachment and set-up, an average time of fifty minutes per piece was saved on previous times.

ENERGY

CUTTERS FOR SOFT COMPOSITION WASHERS

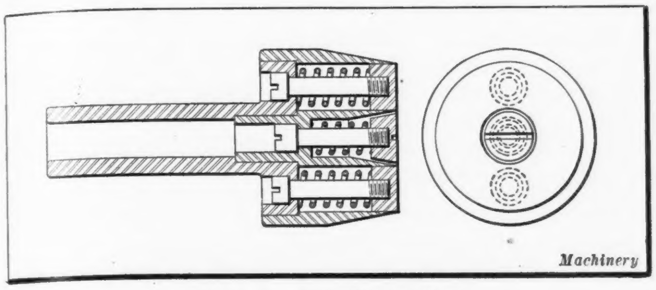
The tool shown in the February number of MACHINERY for cutting washers out of leather, rubber, and other soft material has one disadvantage in that a cutter must be made for each size of washer that is to be cut. This disadvantage is avoided



Adjustable Cutter for Washers of Soft Material

in the tool here shown, which may be used for any size of washer within its capacity. The shank *A* is made to fit the spindle of the drilling machine and terminates in a rectangular bar *B*, which carries the cutting tool *C* and the steel center *D*. This center is a forced fit in the rectangular bar *B*. The cutting tool *C* slides in a slot and is held in position by a set-screw *E*. To make a washer, it is only necessary to set the cutting tool, which is ground to a knife-edge, to the correct radius, place the center *D* in the material, and rotate the tool, which is held in the spindle of the drilling machine. The tool can be quickly set to cut any size of washer desired. A. TOWLER

The tool here shown for cutting soft composition washers is an improvement on that shown in the February number of



Cutter for Composition Washers

MACHINERY. While the initial cost is considerably higher, the possibility of the washers and centers sticking in the cutter is entirely eliminated. The tool is preferably made of steel, and by making the large cutter separate, as shown, a great deal of work and material will be saved when replacing. This cutter will work satisfactorily either on a drilling machine or when used as a punch.

Dubuque, Iowa CHESTER W. HATHAWAY

LAPPING PLATE AND CABINET FOR EMERY WHEELS AND OILSTONES

For the users of ring emery wheels, india or corundum oilstones, or any end-cutting wheels, which are certain to glaze from constant use, the accompanying description and diagram of a lapping, or rubbing-down, plate and cabinet may be of interest. Ring wheels of emery, corundum, carborundum, or other abrasives that are mounted on chuck stems or taper shanks should be trued by a diamond and then rubbed on the cast-iron plate, using either coarse or medium grains of emery, depending on the work to be ground. This operation of rubbing, using a circular motion and frequent turning of the wheel, breaks the lines left by the truing diamond and leaves the surface in good condition. It can be repeated several times, as a wheel becomes glazed by use, before being returned by the diamond.

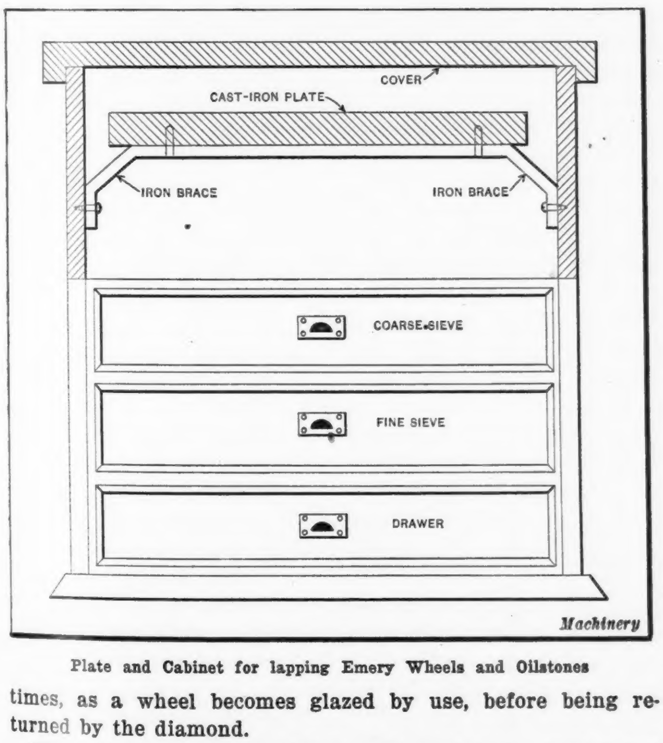


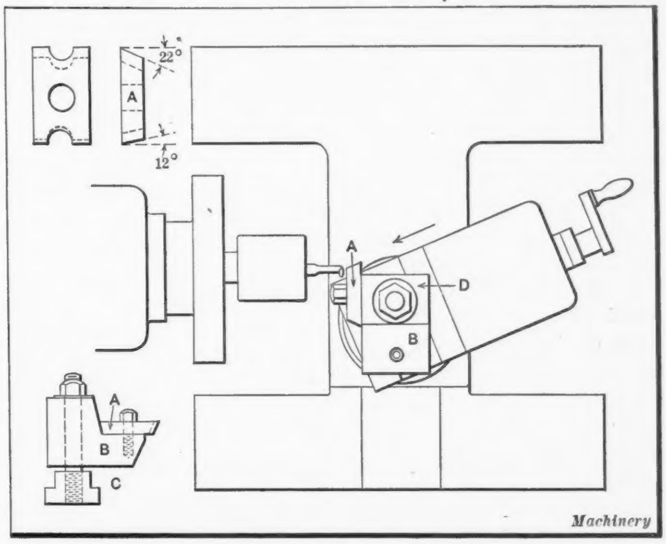
Plate and Cabinet for lapping Emery Wheels and Oilstones

The cabinet, or holder, of the rubbing plate is about 2 feet square and 2 feet, 6 inches high. The cast-iron plate is suspended in the upper part of the cabinet on two iron braces, made of ½- by 1-inch strap iron or cold-rolled steel, and is held in position by two dowels. Directly beneath the plate are two drawers with sieve bottoms to catch and sift the emery. The first drawer has a sieve of the proper mesh to retain the coarse emery; the second sieve is of finer mesh and retains a grade of emery useful for blocking oilstones, permitting all dust to drop to the lower drawer. A small scoop or shovel should be kept with the outfit to clean the plate and put on new emery as needed.

Jersey City, N. J. WARREN H. DUNBRACK

TOOLS FOR FORMING AND RELIEVING CONVEX MILLING CUTTERS

It is often necessary to make convex cutters that are not in stock, and the method to be described has been quite satisfactory for making small lots or special sizes. The form tool shown in the upper left-hand corner of the illustration is made with an arc having a radius at one end which is a little larger than the standard radius of the milling cutter. This end is given a clearance of about 12 degrees and is used for rough-turning the cutter blanks. The opposite end of the forming tool is made to the required cutter radius and is given a clearance of 22 degrees, as it is used for relieving the cutter while finishing it to size. The cutter *A* is held in a tool-block *B*, as shown at *C*, while turning and relieving the milling cutter. This tool-block is also used as shown at *D* when turning or boring the concave or circular part of tool *A* by using a compound rest as indicated in the illustration. Tool-block *B* is set with the face at right angles to the center line of the spindle and the compound rest is set at the required clearance angle. The tool *A* is clamped in position on the side of block *B*. The tool is turned or bored to the required radius by using an eccentric chuck which is held in the spindle. A feeding movement in the direction of the arrow is obtained by the compound rest, and the depth of cut is regulated by the cross-slide. In this way, a true arc is obtained on the face of the tool. It is sometimes necessary to give the tool a little clearance on the sides of the concave surface, but on tools of small radius this is seldom necessary.

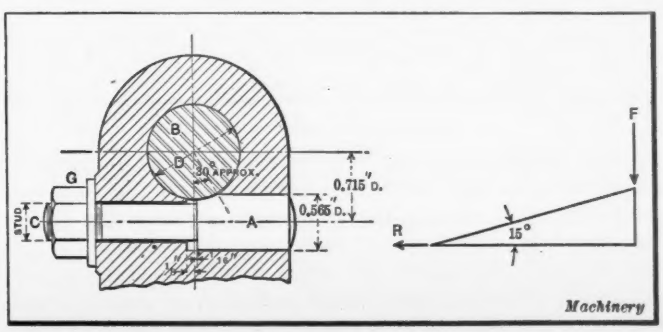


Method of turning Concave or Circular Part of Tool for forming and relieving Convex Milling Cutters

Detroit, Mich. O. F. SCHWEITZER

TANGENT CLAMP

There are at present several methods in general use for clamping pins, rods, screws, and spindles, but the "tangent clamp," owing to its simplicity and effectiveness, is especially applicable, whenever a non-positive clamp can be used. The principle involved is similar to that of the toggle joint or moving strut. Hence, it is possible to formulate an expression of its effectiveness in definite terms. The angle of 30 degrees in the illustration indicates the highest point on



Section showing Design of Tangent Clamp and Principles involved

the stud or cylinder A with relation to the spindle B being clamped, and is about the necessary maximum for both effectiveness and strength. One half of this angle, the mean of the surface in contact, corresponds to the angle of the toggle joint arm or moving strut, and its effectiveness, neglecting friction, is indicated in the diagram, where F = applied force, and R = clamping result on spindle. Then:

$$R \times \sin 15 \text{ degrees} = F \times \cos 15 \text{ degrees}$$

$$R = \frac{F \times \cos 15 \text{ degrees}}{\sin 15 \text{ degrees}}$$

If the angle is increased, the effectiveness is decreased, or vice versa, but it will be found that the mean angle cannot very well be decreased and leave enough metal to resist the thrust. Should the stud be made larger than the indicated diameter, it should be cut away on the top in order to keep the highest point of tangency as near 30 degrees as possible. The tangent clamping stud A should not be hardened, as the clamping effect would be less satisfactory, and the spindle B, or other object clamped, would be marred or chipped. The clamping stud C should be made as large as possible on smaller sizes, and no larger than necessary on large sizes of spindles. It is often desirable to use a quick-operating handle in place of the nut G.

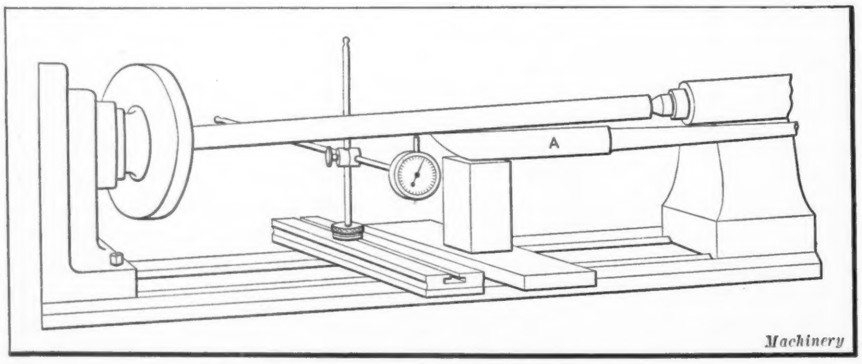
The design shown for drawing the clamping stud against the spindle has proved most effective, but the following methods may also be considered. The clamping block may take the form of a bushing and have a screw running through it into a tapped hole beyond. If this form is used, it is advisable to increase the diameter over that shown in the illustration, and remove the metal beyond 30 degrees, as previously described. A pair of opposing clamping blocks may be used, drawn up and centered upon the spindle by means of a screw through one and a tapped hole in the other. Another suggestion is a stud running through both bushings with a nut at each end.

The proportions shown in the illustration are the results of experiments by the author, and very satisfactory results have been obtained for spindle sizes from 1/2 inch to 3 inches. Many designers have used this type of clamp without giving due consideration to proportioning the parts, and have obtained less satisfactory results.

Washington, D. C. WILFRID GRIFFIN

STRAIGHTENING SHAFTING

For quickly straightening slight bends, such as are found at times in crankshafts and shafts of small diameter, the



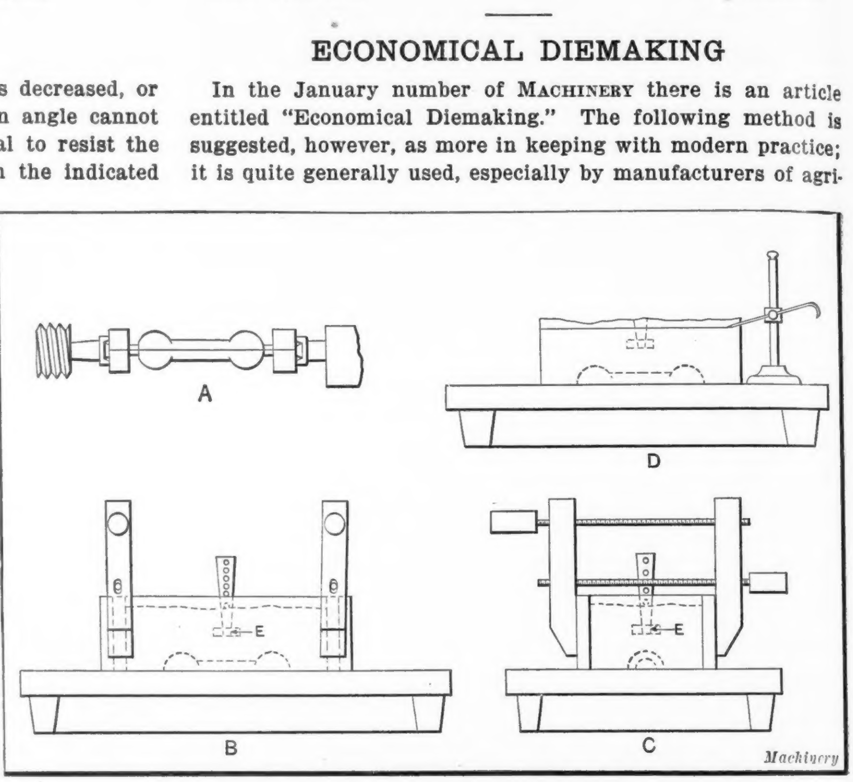
Method of straightening Slight Bends in Shafts

indicator should be placed beneath the shaft, as illustrated, and adjusted so that when the shaft makes half a turn the instrument will register the amount, in thousandths of an inch, that the shaft is out of true. Assuming that the indicator registers 0.004 inch, the shaft should be bent upward 0.002 inch. Without removing the indicator, by means of the crowbar A the shaft is bent upward, and then carefully lowered into contact with the indicator, which shows if more or less pressure on the crowbar is required in the next bend. By having everything needed for the operation in place, no time is spent resetting the indicator, laying down the crowbar, picking it up again and starting and stopping the machine to see if the shaft is running true. The writer has found this method to be generally satisfactory.

New York City E. J. HIGGINS

ECONOMICAL DIEMAKING

In the January number of MACHINERY there is an article entitled "Economical Diemaking." The following method is suggested, however, as more in keeping with modern practice; it is quite generally used, especially by manufacturers of agri-



Making Plaster-of-paris Molds for Dies

cultural implements where a large number of plaster-of-paris dies are made for straightening malleable castings, bending operations, and forging. The model shown at A is the same as that shown in the previous article.

The model should be turned from two pieces of wood, which are joined and held together by pinch-dogs or by gluing with a paper joint. The centers for the lathe must be located on the joint. After the pieces are turned, they will separate at the joint and thus eliminate the necessity of sawing and joining to the center line. The model is then placed with its joint flat on a faceplate and the box is placed in position. The sides of the box should not be nailed together or fastened permanently, but should be held together by clamps, as shown at B and C. As plaster-of-paris does not shrink, or change its shape, it is difficult to remove a mold from a solidly built box. A piece of cast iron E drilled and tapped for a foundry draw-screw should be suspended in the center of the mold by passing a rod, the ends of which rest on the sides of the box, through one of the holes in the tapered mandrel to which the draw-plate is screwed. After the plaster is poured, the tapered mandrel is removed, leaving the draw-plate firmly embedded in the plaster form.

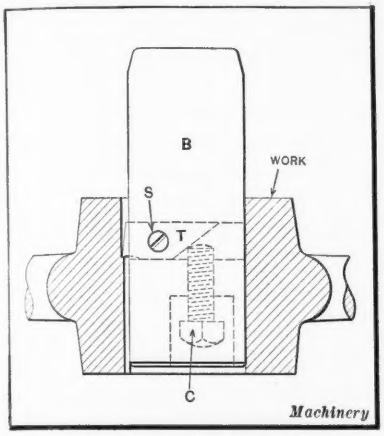
The plaster should be mixed thin enough to pour and conform perfectly to the shape of the model and then poured into the box. After the plaster has set, the box can be removed by taking off the clamps, when the sides will easily come away from the form. Before the plaster form is lifted from the faceplate, a thickness line should be scribed at the top by using a surface gage, as shown at D; this will give a plain surface true to the center line of the model. By varnishing the wooden model and the sides of the box with shellac and covering the surface with a thin coat of oil or vaseline, a perfect surface will be produced, if the plaster has been sufficiently mixed to work out the air bubbles. The blocks or sides for the box

may have draft or be of almost any shape that will leave the form in condition for the foundry after the surface grease has been scraped off and the form given two coats of shellac.

Peoria, Ill. PAUL L. HATFIELD

KEYSEATING TOOL

In the January number of MACHINERY a tool for cutting keyseats when no keyseater is available is described. This tool is not uncommon in small mill repair shops where the machine equipment is usually limited and the range of work very large, but using the tool in the spindle of a drilling machine is a novelty, and it is readily seen that small keyseats, 1/4 or 3/8 inch wide, can be cut more quickly in this manner than by the method to be described. The accompanying illustration shows a tool which is practically the same as that described in the January number except that it is not used as an attachment to a machine. The cutting action is accomplished by driving the tool through the work with a sledge. The bar B is a sliding fit in the bore of the work and carries the tool T in a slotted hole. The tool is held rigid by a headless set-screw S and is adjusted for the cut by screw C. The distance from the lower end of bar B to the tool should be long enough to serve as a pilot at the beginning of the stroke, and the total length of the bar should be a little longer than the longest keyseat to be cut. The head of adjusting screw C enters a counterbore, to protect it from injury when the bar falls through the work. The screw should never project beyond the end of the bar, and it is, therefore, operated with a socket wrench. Very light cuts should be taken during the first few strokes to lessen the possibilities of the bar turning in the work. Keyseats up to 3/4 inch have been cut successfully in this manner.



Tool for cutting Keyseats

Olean, N. Y. E. J. GIBSON

VALUE OF REPAIR LISTS FOR REPAIR ORDERS

The article on page 642 of the March number of MACHINERY, entitled "Ordering Parts for Machine Tool Repairs," was read with great interest, and the solution of the problem suggested by the author will eliminate much of the trouble caused through lack of definite information as to what is desired in filling an order for repair parts. However, merely attaching to the machine a brass plate upon which is stamped the manufacturer's name and address and some serial or shop order numbers requisite to its identification does not remove all danger of confusion.

In filling in the requisition to the purchasing agent for a broken part, the question might arise, "What is the part called?" "What is its correct technical term?" Sometimes the owner, fearing that the manufacturer might misinterpret the order, sends the broken piece by parcel post or express, thereby causing additional expense and the possibility of losing the part in transit. In the case of an ordinary type of machine tool, say a planer, sold to manufacturers of drilling machines, milling machines, or other machine tools, there should be no cause for error or delay, for the reason that the names of the parts of the machine are generally well known. But where a repair order is for a machine of intricate design or one containing a cumbersome gear-box mechanism, quite a different angle of the situation is presented. Also, should one of the many contacts wear down or a magnet burn out on a controller forming part of the electrical apparatus on an elevator, the same condition might arise.

In certain electrical lines, the manufacturer sends a repair list with the finished product. This list consists of a diagram of the assembled unit on which are placed the names of the various parts entering into the design, together with their piece or pattern numbers. The fact that the piece number is given on a repair order often has been the means of knowing what is wanted, particularly where the manufacturer's records are somewhat misleading. Why cannot this method be adopted in the machine tool industry? It is not essential that an assembly drawing of the complete machine be sent; just a simple line drawing, without dimensions, of the units subject to repair orders is sufficient.

Cincinnati, Ohio JOSEPH PLOGMANN

FIGURING IN THE METRIC SYSTEM

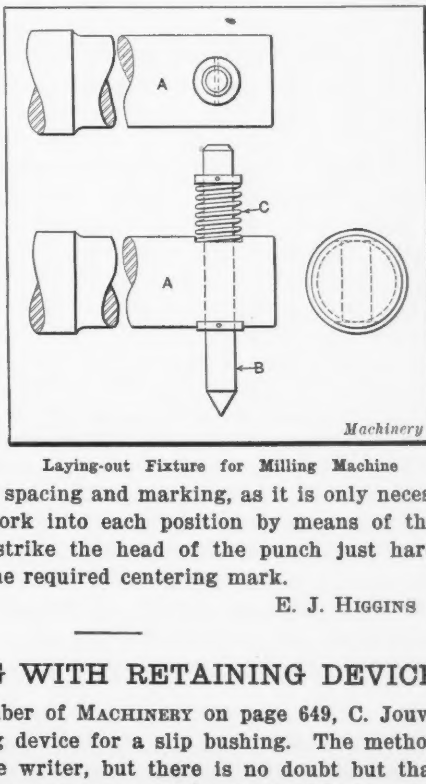
Now that we are doing so much foreign work, we are encountering metric dimensions at every turn. It seems to be the common practice to convert the metric dimensions into decimal equivalents and work with these. That is all very well. But when it comes to figuring out dimensions from metric drawings, especially when the foreign inspectors use metric gages, a lot of time and work can be saved by using the metric figures all through the calculations and converting the answer only. Time and again draftsmen in solving such a problem, for instance, as finding the square root of 5 squared plus 6 squared (metric dimensions), which can be done with very little effort, convert these figures into decimal equivalents first and then have an example like this: finding the square root of 0.19685 squared plus 0.23622 squared.

Why wrestle with all those figures when the problem could almost be done without even a pencil and paper? Further, there is a slight error every time a figure is converted, which means quite a variation in a long calculation. It is strange that the same draftsmen who design labor-saving jigs and fixtures do not take their own medicine and cut down labor and insure greater accuracy. Still, that is what is found in so many cases that the writer brings up this point.

Hartford, Conn. J. C. P. BODE

LAYING-OUT FIXTURE FOR MILLING MACHINE

In the April number of MACHINERY, on page 744, there appears an illustration of a laying-out fixture for use on a milling machine. In the accompanying illustration is shown another design of fixture for holding a center-punch. The arbor A fits the spindle of the milling machine, and should be held in such a position as to bring the punch B perpendicular to the axis of the work, which is held between the centers of the indexing head. The center-punch is held up from the work by the spring C. This fixture permits rapid spacing and marking, as it is only necessary to bring the work into each position by means of the indexing head and strike the head of the punch just hard enough to produce the required centering mark.

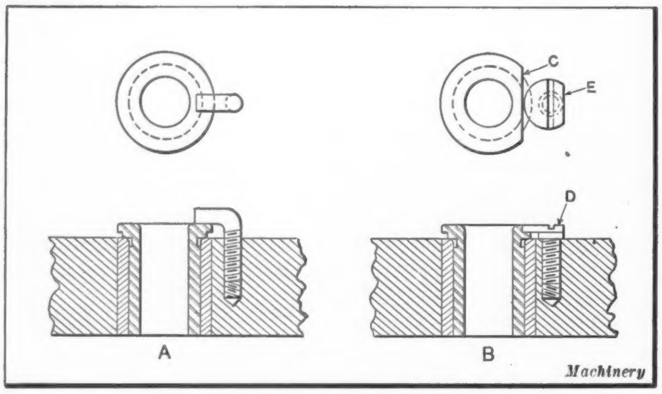


Laying-out Fixture for Milling Machine

New York City E. J. HIGGINS

SLIP BUSHING WITH RETAINING DEVICE

In the March number of MACHINERY on page 649, C. Jouve describes a retaining device for a slip bushing. The method shown is new to the writer, but there is no doubt but that it serves the purpose in view. A criticism that might be made



Retaining Device for Slip Bushings

is that the same end could be obtained by a much simpler and cheaper device. In the accompanying illustration at *A* is shown about the cheapest retaining device which can be made. This consists of a piece of steel wire about 1/4 or 5/16 inch in diameter, which is screwed into a tapped hole in the wall of the jig or fixture. The upper end of the wire is bent as shown. When it is desired to prevent the bushing from being drawn out with the drill, the wire is turned to the position shown. When the bushing is to be removed, a quarter turn of the wire brings the bent portion into a position that allows the bushing to be taken out. It is sometimes desirable that the face of the bushing be used as a stop for counterboring, spot-facing, or similar operations. Under such conditions, any retaining device that projects above the face of the bushing is useless. In the illustration at *B* is shown a good retaining device which may be used when conditions such as noted are necessary. It is neat, easily made, and convenient to use. The head of the slip bushing is machined with a flat, as shown at *C*. The retaining screw *D* has a portion of the head cut away as shown at *E*. The distance between the center of the screw and the flattened portion must be slightly less than the distance between the center of the screw and the edge of the slip bushing. When the screw is in the position shown, the bushing cannot be removed and any spot-facing or similar operation may be performed without danger of the tool interfering with the retaining device. When it is necessary to remove the bushing, a half turn of the screw brings the flattened part in such a position that the bushing may be taken out.

Providence, R. I. ROBERT MAWSON

INVENTIONS AND INVENTORS

The article on page 703 in the April number of MACHINERY is a rather severe indictment of the laws under which the inventor works and the financial pirates among whom he falls. The patent, it is stated, gives absolutely no protection (unless there is capital behind it), while the patent laws require that inventors reveal their inventions to the public; the inference is that this is a most unfair state of affairs, a theorem for which the writer of the article presents little proof.

The grant of a patent is an agreement between the Government of the United States and the inventor by which, in consideration of free public use after seventeen years, the Government grants to the inventor exclusive use of the child of his mental vision during that period. But this product must have sufficient personality to be differentiated from thousands of similar cherished offspring of inventors. The writer has been doing his share for thirty years to increase the number of inventions and, on the whole, he has no complaint to make of the treatment he has received from the Government, on the one hand, or from the "pirates of finance," on the other.

In many instances, not only has the patent grant secured to the inventor his just rights but it has also enabled him to bar progress in an art. Our patent laws in this respect are far too favorable to the inventor. They should compel the inventor to work his invention or license its use to those who will. Right here is where the inventor usually flounders. The Government grants his patent, but unfortunately it can neither furnish him business experience nor a sense of values, and as a result he often demands a price and terms for his invention that prevent any sane business man dealing with him.

Lump-sum price demands have wrecked the chances of many inventions. Still it is safe to say that no really good thing in any line goes begging if offered on a reasonable royalty basis, coupled with a minimum yearly compensation to insure working by the licensee. Too often the inventor demands that the manufacturer shall take all the chances of business failure or success when both the manufacturer and the inventor would be better served by the safer and more just basis of royalty, which instead of being a myth is both a common and an essentially workable form of agreement. There are business pirates, of course, as there are violators of all laws, but this is no reason for an inventor to whine for more protection from without. What he needs is more horse-sense in marketing his wares, and this it is fervently hoped the Government will not attempt to furnish. As a guild, inventors are in no need of particularly tender care because their "imaginative, sensitive, suspicious, and reclusive" natures cannot stand the treatment men get in other lines of endeavor. As the writer knows them, they are far from being a race apart who must be humored to secure the rich flow of their inventive genius; oftener they are intensely practical, of wide business experience, and do their work under the spur of business necessity. At least they go about their task without whimpering and get such reward as comes to men who work hard and well.

St. Paul, Minn. E. E. JOHNSON

SAVING TIME IN MAKING DRAWINGS

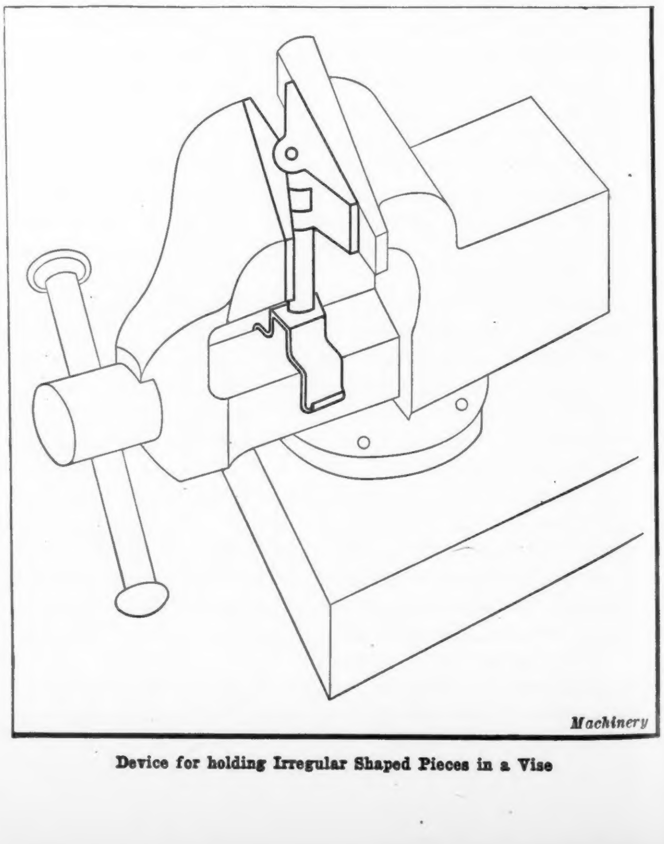
In the article "Saving Time in Making Drawings," on page 649 in the March number of MACHINERY, Mr. Perlman refers to a thin piece of celluloid shellacked to the drawing as being an improvement over horn centers. The writer agrees with him, but believes the following method is even better: Use a piece of Dennison's gummed cloth tape about 3/16 inch square and leave it on the drawing. It will then always be ready for use.

New Britain, Conn. F. E. POTTER

EQUALIZING VISE JAWS

The equalizing jaws illustrated are handy for gripping irregular shaped and tapered work in either a machine or bench vise. The faces of the jaws can be serrated to insure a firm grip, and then hardened.

Concord, N. H. CHARLES H. WILLEY



Device for holding Irregular Shaped Pieces in a Vise

HOBS AND HOBBING[1]

The method of producing gears by hobbing has been understood in its theoretical aspects for many years, but conditions, which are now radically changed, delayed its general adoption until recent years. One of the early conditions which retarded progress was the fact that quantity production in its present meaning did not then exist, and quantity production is the field to which the hobbing process is especially well adapted. The introduction of the automobile and its manufacture on a large scale necessitated the manufacture of duplicate gears in very large quantities, and thus afforded a chance for the hobbing process to show its capabilities, but it still lacked the refinements necessary to enable it to do high-quality finishing work.

From a study of the various methods of cutting gears and a consideration of the advantages and disadvantages of each, an ideal system would have the following characteristics:

1. A continuous cutting action, as in milling with a disk cutter.
2. Generation of each tooth by a single tooth or tooth profile, as in the single tooth generating process, so that each tooth will be a duplicate of its mates.
3. Distribution of the cutting action around the blank so that an even heating may take place.
4. Continuous indexing by rolling so that inaccuracies in spacing by intermittent methods may be eliminated.

The hobbing process has all these characteristics. The cutting action of the hob is obviously a continuous milling cut. Each tooth in the gear is generated by the same set of teeth in the hob. An inaccurate hob may produce an incorrectly shaped tooth; but even so, all the teeth will be alike. Both work and cutter rotate rapidly, thereby assuring uniform distribution of heating and expansion. The indexing is continuous by rolling. Every revolution of the hob spaces out a tooth on the blank as it rotates, in proper relation with the latter. The indexing is in no way affected by shock and jar, as in the intermittent method.

It being accepted that the hobbing process combines these desirable features, the problem then is to design a machine to give practical effect to them in the best manner. The trend today is toward specialization, and it is well recognized that making a specialist of a machine, while limiting the range of work to which it is applicable, is profitable for quantity production, because it increases its efficiency on the work within its range. Applying this view to hobbing machine design, it seems apparent that by limiting the diameter of the gears to be cut to twelve inches and the diametral pitch to 3, a machine can be produced having great rigidity for the kind of work expected of it, and at the same time having a range sufficient to cover most of the quantity production. Being a manufacturing machine, speedy loading and unloading should be a main feature of the operation. The vertical arrangement of the work-spindle lends itself to machines of large capacity, as a more compact design can be worked out with this arrangement than is possible with the spindle in the horizontal position, but for a range of sizes up to twelve inches, the horizontal arrangement has many advantages. In the quickness with which the work can be loaded, in combination with the stiffness that can be built into the work-supporting means, the horizontal machine is superior to the vertical type. Cleanliness is another feature in favor of the horizontal spindle, as chips fall clear of the work-support and do not hinder speedy reloading nor impair the accuracy of the results. Therefore, for the machine in view, the horizontal work-spindle is superior. The hob support should be arranged with a minimum overhang and a simplicity of design that would give the results desired.

From the first, the hobbing process has proved itself to be a rapid method of producing gear teeth, and for this reason its advocates have had little difficulty in demonstrating its ability for roughing, where quantity is required. The hobbing cut has the advantages of being continuous, of breaking up the chip, of operating on a rotating blank, thus equalizing the load and distributing the heat, of having no portion constantly under cutting action, thus facilitating heat radiation and dissipation, and of distributing the load upon a great many teeth, no tooth removing metal for its whole depth, therefore facilitating a rapid and complete circulation of the cutting compound. The constant rolling indexing method of spacing the teeth also allows a much higher operating speed than is practicable with intermittent spacing devices.

But roughing is not the only consideration. Gears require to be finished, and finished with a high degree of accuracy, especially at the present time. As the demand for accuracy in the gears increased, and as the use of high-speed steel became a necessity in economical production, the relative disadvantages of the hobbing process in finishing became more marked, and today, for high-class finishing, it would be out of the race entirely if there were no means available for correcting the hobs after hardening. Fortunately, such a means exists today in the modern ground hob.

Duplicate hobs of any form can now be made with reliability and certainty, and the hob can be set to cut on any part of its surface without changing the result in the finished gear, so that the whole wearing life of the hob can be utilized, whereas with hobs that are not ground, the distortion of hardening often results in there being one point on the hob which will produce good results, whereas no other place on the hob will do so. The hob which is formed and not ground is still recognized as the proper tool for roughing, and it may be used for some classes of finishing, but not where a high quality is required, for, although it will make all the teeth in the gear alike, it cannot be relied upon to give an accurate tooth shape unless every tooth in the hob follows in proper relation, without zig-zagging from the theoretical path. There are a number of causes that account for the zig-zag or drunken path that the hob tooth of an unground hob may take. Sharpening is a cause of wide variation in the relation of one tooth to its adjacent mate, but can be corrected to a degree that reduces the error from this source to a minimum. The teeth of the hob must necessarily be equidistant from the axis at the cutting edge to get a continuous true relation of one to the other. Hardening is most difficult to control, as the materials of which hobs are made require high heats and cold quenching, setting up strains that cannot be predetermined. Hole grinding is also a cause of variation. This, however, can be corrected to some extent in sharpening. Relieving the thread is often the cause of error, even though the operation is performed on heavily constructed machines. The material is not always ideal in working qualities, no matter how carefully the steel is manufactured, heated or treated, and variation in hardness, even in the same bar, is a cause of error. These difficulties have defied the art of the hob maker and forced him to resort to grinding, which today is entirely successful and practical.

Aside from the production of spur and spiral gears, the hobbing process has a further field in the production of spline shafts, which have come into such common use in automobile construction, and which are now being more and more adopted in other lines. The spline shaft owes its popularity and, from a manufacturing standpoint, its practicability to two modern processes—pull-broaching and hobbing.

Hobbing is particularly well adapted to spline shaft generating, as in this work the uniform distribution of the heating effect is even more important than in cutting gears, and added to this is the fact that in making spline shafts by milling with intermittent indexing methods, the releasing of surface strains from one side of the shaft at a time throws the shaft out of true and makes accurate results extremely difficult to attain. This is not so in hobbing, because the stock is gradually removed from all sides at once, working progressively from one end, the effect of the removal of stress-resisting material is balanced, and no distortion takes place.

Besides these important features, we have the accurately indexed keys, each a duplicate of the other, with off-center keys eliminated, and added to all this is the high rate of production. There is no limit to the number of keys it is possible to hob with little or no increase in production time for shafts

[1]Abstract of a paper by F. G. Hoffman and John Edgar, of the Barber-Colman Co., Rockford, Ill., read before the American Gear Manufacturers' Association convention at White Sulphur Springs, W. Va., April 18 to 20, 1918.

of equal diameters. This has undoubtedly led to the present wide adoption of shafts, particularly for axle drives, with eight, ten or more keys, giving a greater root diameter for a given key driving strength, the accurately indexed splines distributing the load evenly.

Another field that the ground hob has opened for hobbing is the silent chain sprocket. Sprockets of a large number of teeth have been handled successfully by the formed hob, but those with a small number require the greater accuracy of the ground hob. Hobs are used extensively to cut teeth in roller and block chain sprockets. These are usually range hobs, each covering a small range in numbers of teeth possible with each hob. Special cases of hobbing also include those in which teeth in ratchets, slotting saws, burrs, etc., are generated. Hobs may be made to generate almost any toothed section that has teeth equally spaced on a cylindrical base; it is not necessary that the teeth be symmetrical on an individual axis.

* * *

THE MACHINE TOOL INDUSTRY AND THE WAR[1]

It has been stated a great many times that the machine tool industry is a fundamental industry, and this is especially true during war. Therefore, it should be clearly and fully drawn to the attention of everyone in this industry that he should do his utmost to increase production of a kind required by the Government, and, with this in view, to overcome all of the many known obstacles in the way. These obstacles might be enumerated as a shortage of skilled labor for the machine shop; the moving about from one community to another of labor, both skilled and unskilled; and the difficulty of securing certain materials.

Attention should be paid to the fact that it is not possible to produce the larger sizes of machine tools, which apparently will be urgently required, at short notice, and a program should, therefore, be laid out as far in advance as possible, so that when production is demanded the proper machinery will be in readiness. Attention should also be paid to the fact that the smaller sizes of machine tools seem plentiful, and the supply of these is probably greater than the demand. There is, however, a scarcity of the larger sizes of machine tools, most of which are wanted quickly.

Great care should be taken in making plans to meet the labor shortage. First we must stop, in so far as it is practical to do so, this bidding for men, which causes them to move from one community to another. To the time lost in transporting these men may be added that consumed in teaching them new occupations, which later are abandoned as the men become dissatisfied with their new surroundings. In short, men should be convinced that they are best serving their country by remaining on the jobs they know best. The mechanical trades have developed so rapidly during the last few years that there is naturally a shortage of skilled labor, and we must look the facts in the face and start to make skilled labor out of unskilled labor. This applies to both man and woman labor. This is one of the most important things to bear in mind, because there could be no greater catastrophe than to find the machine tool shops of this country so undermanned that they could not produce the necessary machine tools for the building of aircraft, machine guns, cannon, and ships; in fact, everything for which machine tools are used.

The creation of a vast army and of the accessories that go with it has been a tremendous job. When it is considered that within one year this nation has been transformed from an unmilitary nation into one that has fast become a great military power, it is no wonder that there have been some disappointments and much criticism, both among our allies and in this country, but it is time for all thoughtful men to take themselves in hand and to stop all criticism which is idle and malicious, or made without good reasons. Big men, as a rule, can stand honest and just criticism, and perhaps that kind of criticism, particularly if it is constructive, is good for any of us, but it must be constructive, or else it may do more harm than good. Words of encouragement do more toward creating efficiency than bitter criticism and denunciation.

Everyone today is reasonably familiar with the advanced cost of almost every commodity. The machine tool builders have had to pay the advanced cost of labor, of cast iron, of steel, of bronze, and, in fact, of all material which enters into the construction of machine tools. They know also that the overhead burden has been greatly increased, brought about largely by the necessity of manufacturing with greater speed than before and by the necessity for training operators who had no previous knowledge of the trade, but who had to be paid while they were being taught. This naturally has made it necessary for every machine tool builder to increase his selling prices. When the increased cost of almost every article is taken into consideration, there can be no criticism at the modest advance of prices in the machine tool industry. This is particularly true of the older builders of machine tools, who have reputations to maintain and who expect to remain in the machine tool business in the future; but it is hoped and believed that every member of the National Machine Tool Builders' Association will consider the necessity of his country at war, and therefore advance his prices only as it becomes necessary. There is, of course, such a variety of machine tools, as regards design, workmanship, accuracy, and productive capacity, that they are difficult to compare, but it is urged that every member of the National Machine Tool Builders' Association make it his duty to keep his selling price as low as good business practice will permit.

In this connection we should remember our debt to our allies, to Great Britain, to France, to Belgium, and to Italy, as well as to others who are aiding us in this great struggle. We have advanced them moneys and credit, but they have given largely of those things which no man can replace, namely, their limbs, and blood, and many of them their lives. We have sent them machinery and equipment which they have carried, through their own personal effort and great sacrifice, to the various front lines where they have laid down everything that they hold dear in this stupendous struggle for world freedom. Our responsibilities are even greater than they would have been had we plunged into the struggle at an earlier date. Therefore, we should exert ourselves the more to make up for this lost time, and all of us should pause and determine in our own minds what might have happened had not our European allies held back the enemy. However, we are all now working, giving, fighting, and dying together for a great cause, and it is a hope and belief that when this great struggle ends in a tremendous victory for the Allies, the love and cooperation born of this enormous sacrifice will be evident in the peaceful pursuit of both business and pleasure, and as we visit the countries of each other as friends do, we shall all feel ourselves a part of the great Allied family.

[1]Abstract of an address by J. B. Doan, president of the American Tool Works Co., Cincinnati, Ohio, presented before the National Machine Tool Builders' Association convention, Atlantic City, May 16-17, 1918.

* * *

LICENSING FOREIGN TRADE

To prevent the useless consumption of materials and labor in making articles that, for the present, may not be exported, and to save tonnage, exporters are required, under regulations in force since May 15, to obtain the written approval of the mission sent to this country by the country to which the exportation will be made. On July 1, all outstanding licenses granted on or before May 14 will be revoked. Any goods not then exported against such licenses may be shipped only if licenses are secured after being approved by the mission of the country to which the goods are to be sent.

On and after May 27, no commodities, except in a comparatively few cases covered by general import licenses, shall be approved for shipment to the United States by the consuls in any country in the world until applications for licenses have been acted upon favorably by the War Trade Board, and the number of the United States license covering the shipment is submitted. This practice has been effective in connection with the restricted list, but the present ruling makes it applicable to all commodities. This rule will prevent unnecessary production in any of the nations allied against Germany.

MACHINE TOOL REQUIREMENTS OF THE ORDNANCE DEPARTMENT[1]

A SPECIFIC OUTLINE OF THE LARGE MACHINE TOOLS NEEDED BY THE GOVERNMENT IN THE NEXT YEAR

WHEN problems of such magnitude as are arising today come up for action, it is impossible to handle them through the recognized channels of peace times; and so the Ordnance Department has, in the past, frequently called upon machine tool manufacturers for assistance not only in expediting the delivery of machine tools so urgently required, but also in determining the requirements of the machines necessary to build certain types of ordnance. The machine tool builders have given the services of their engineers to the Ordnance Department for this work of organization, as it was felt by the latter that the best results could be accomplished by making up a tentative schedule of machine tool requirements for some of the most important types of ordnance, rather than by eliminating the preparatory engineering work and ordering machine tools indiscriminately, trusting that enough of them would be fitted for the work to take care of the various contracts. By this preliminary time-study work, it is safe to say that the purchase of probably several million dollars' worth of unnecessary machine tools has been avoided, thus relieving, to a certain extent, the tense machine tool situation that existed last fall.

How the Machine Tool Builder can Serve the Government

The question has often been asked: How best can the machine tool builders serve the Government? This may be answered broadly by stating that they can best serve by turning out as many machine tools as possible in the quickest possible time. There are, however, so many phases of the problems to be considered that they may be enumerated in their order of importance.

The Ordnance Department asks for a greatly increased production of large machine tools. The success of the program for large guns depends upon the output of heavy machines for the remainder of the year. In other words, the success or failure of the 1919 drive, as far as the use of large caliber guns is concerned, rests squarely upon the shoulders of the machine tool builders who are expected to carry that load. The machines available are insufficient, and it is understood, from reliable information, that unless the present rate of output for large machine tools is considerably increased, the program for large guns will be jeopardized. The members of the National Machine Tool Builders' Association are in the best position to work out a successful plan to produce the required machines, and they are asked to cooperate with the Machine Tool Section of the War Industries Board to determine how the results can best be obtained.

Closer Contact with War Industries Board

Closer contact should be maintained between the National Machine Tool Builders' Association and the Machine Tool Section of the War Industries Board, so that the members of the association can, at all times, be fully informed as to the requirements of the Ordnance Department, as well as of the other branches of the National Government. The time has arrived when it may be necessary for certain machine tool builders who have, in the past, strictly adhered to certain types and sizes of machine tools, and who have enjoyed a national reputation as the manufacturers of these tools, to change their commercial commodity. The time has arrived when it is not a question of maintaining past standards, but of manufacturing types of machinery that are most urgently needed.

A manufacturer who is equipped for making certain machine tools for which there is no urgent demand by the Government should immediately take steps to devote his energies to some type of machine for which there is a demand; or, if his equipment is such that he cannot change to some other type of machine tool, then it is his duty to inquire into the needs of the Ordnance Department to determine what material he can supply with the equipment that he has.

[1]Abstract of an address made by Lieutenant-Colonel H. W. Reed before the National Machine Tool Builders' Association convention, at Atlantic City, May 16-17, 1918.

By keeping in close touch with the Machine Tool Section of the War Industries Board, machine tool builders can, at all times, be posted as to the machine tool requirements of the Government; and the Machine Tool Section of the War Industries Board should be able to advise them as to the advisability of changing from machine tools to straight ordnance manufacturing, provided their equipment is such that it would be impossible for them to produce machine tools which the Government really requires; and it is felt that with the Machine Tool Section of the War Industries Board acting as the intermediary between the Ordnance Department and the machine tool builders, an alliance can be formed between these two bodies that will be extremely beneficial to both. It should be remembered, however, that in approaching the Machine Tool Section of the War Industries Board, the machine tool builder should be in the frame of mind to accept the Government's decision as to what they can best build to suit the Government's needs, and not consider what they would like to build to suit their own convenience.

Advice Needed as to Best Machines

It has been suggested that far too little time is devoted by the machine tool manufacturers in assisting their customers to determine what machine tool equipment would best suit their requirements. During peace times, every progressive machine tool manufacturer would check up the requirements of his customers so as to be assured that each tool sold to the customer was the one best fitted for his needs. This service has probably been discontinued to a certain extent, for two main reasons:

1. Owing to the enormous demand for machine tools during the war period, it was not necessary for machine tool builders to solicit business; and, therefore, it is very easy for them to discontinue their engineering services, which heretofore had been given to the operating departments of their customers' plants.

2. Owing to the general unfamiliarity as to the machine tool requirements for ordnance work, the machine tool builders have been loath to offer any suggestions as to what tools would be best fitted for the manufacturing of ordnance material.

The result has been that, all too frequently, equipment has been sold to manufacturers holding contracts for ordnance material which was not suited for their needs. Because of the vast amount of new material to be manufactured, and the difficulty in securing the proper personnel for the Ordnance Department, it has been practically impossible to determine in detail the machines required for all classes of ordnance material; and, because of these difficulties and the lack of advice from machine tool builders, quite a large number of machine tools have been delivered that are unsatisfactory for the work they are expected to perform.

The machine tool builders should realize that it is necessary to let contracts for ordnance material to manufacturers who have had little or no experience in the past on up-to-date machine shop practice; and, therefore, they should increase the service heretofore rendered their prospective customers in advising them as to what they should and should not buy. To illustrate this point: Upon checking the machine tool list submitted by a contractor of the Ordnance Department recently, it was discovered that he proposed to buy one hundred and eighty 12-inch lathes. Had these lathes been purchased, it would have been impossible to use any of them on the contract. While admitting that this is an extreme case, it might frankly be stated that every government contractor would have been benefited had the machine tool builders cooperated to their fullest extent in advising the types and sizes of machines to be purchased.

Another important service in which the machine tool builders can assist the Ordnance Department is in driving the machine tool parasites out of business. Such men reflect discredit upon the industry as a whole, even though those of us who are well informed realize their actions are not tolerated

by the machine tool builders, and it is requested that the manufacturers and legitimate sales agents use their influence towara the elimination of the pernicious activities followed by this class of men.

Machine Tool Requirements for the Coming Year

As stated in a letter from Mr. Merryweather, chairman of the Machine Tool Section of the War Industries Board, the present requirements of the Ordnance Department for machine tools are, in general, as follows:

> The American machine tool industry is apparently well able to cope with all the demands that may be made on it for small and medium size tools up to approximately 24-inch lathes; 24-inch planers; 36-inch vertical boring mills; radial drilling machines up to 4-foot swing; all small drilling machines; turret lathes; automatic screw machines; surface grinders, etc. There is, however, much evidence of a dangerous shortage of planers, lathes, slotters, vertical and horizontal boring mills, radial drilling machines, and milling machines of sizes larger than those specified above.

A summary of the large machines required and the estimated value is given in the following:

Combination Boring and Turning Lathes—Sixteen, 85-inch by 50-foot; six, 75-inch by 50-foot; three, 52-inch by 50-foot; fifteen, 72-inch by 50-foot; two, 52-inch by 30-foot; and five, 72-inch by 20-foot.

Boring Lathes—Twenty-eight, 54-inch by 12- to 22-foot; five, 40-inch by 50-foot, double-end; eighteen, 50-inch by 25-foot, double-end; eight, 40-inch by 25 foot; one, 32-inch by 25-foot, double-end; two, 72-inch by 30-foot.

Turning Lathes—Two, 36-inch by 6-foot; seventeen, 60-inch by 6- to 26-foot; twenty-nine, 54-inch by 6- to 24-foot; eight, 70-inch by 50-foot; twenty-two, 72-inch by 30-foot; ten, 85-inch by 50-foot; four, 60-inch by 50-foot; five, 48-inch by 30-foot.

Planers—Twelve, 48-inch by 12-foot; ten, 72-inch by 16-foot; five, 60-inch by 14-foot; six, 48-inch by 14-foot; twenty-five, 36-inch by 12-foot; five, 96-inch by 24-foot; fourteen, 120-inch by 30-foot; eight, 64-inch by 24-foot; three, 42-inch by 16-foot; one, 120-inch by 24-foot; four, 72-inch, open side.

Slotters—Six, 36-inch; one, 30-inch; five, 24-inch; six, 12-inch; three, 48-inch; eight, 14-inch; eleven, 26-inch; three, 10-inch; three, 18-inch.

Radial Drilling Machines—Eight, 6-inch; thirteen, 5-foot.

Milling Machines—Four, 6-inch spindle, horizontal; seven, No. 6 vertical; six, No. 5 vertical; two, No. 3 universal; two No. 5 universal, horizontal; three, No. 4 plain; three, No. 4 universal; six, No. 3 plain.

Vertical Millers—Two, No. 6; eight, No. 5; two, No. 3; two, No. 4.

Horizontal Boring Mills—Twenty-nine, 4-inch; six, 5-inch; five, 6-inch; three, 3-inch.

Vertical Boring Mills—One, 14-foot; eight, 20-foot; one, 12-foot; five, 10-foot; eight, 48-inch; seven, 72-inch; three, 66-inch; eight, 90-inch; eleven, 60-inch; three, 50-inch; one, 96-inch; three, special.

Floor Boring Mills—Three, 7-inch by 7-foot; two, 7-inch by 5-foot.

Rifling Machines—Three, 50-foot; two, 30-foot.

Miscellaneous—Eighteen, 48-inch jump lathes; three, 60-inch gear-cutters; two, 24-inch gear-hobbers; three, 24-inch by 8-foot grinders; three, 72-inch gear-cutters; two, draw shapers; one, No. 4 gear-cutter; three, No. 5 gear-cutters; one, 16- by 50-inch grinder; one, 10- by 72-inch grinder; one, 18-inch rotary saw; three, 26-inch shapers.

Summary of Machines in Great Demand

Boring Lathes	$1,239,000
Turning Lathes	1,747,000
Combination Boring and Turning Machines	1,535,000
Radial Drilling Machines	83,000
Milling Machines, General	165,000
Milling Machines, Vertical	33,000
Milling Machines, Horizontal	306,000
Vertical Boring Machines	1,150,000
Horizontal Boring Machines	306,000
Slotters	332,000
Planers	2,118,000
Rifling Machines	146,000
Floor Boring Machines	52,000
Miscellaneous	170,000
Total	$9,382,000
Value of Available Tools	924,000
Total Estimated Cost	$10,306,000

It has been stated that the mechanical power of an army in the field may be measured by the industrial army at home, making the necessary munitions of war; but beyond this, the efficiency of the manufacturing industrial army may be gaged, not only by turning out an adequate number of machine tools, but also by turning out the types that will perform the best service for manufacturing the ordnance material required. If the machine tool builders will do their part by turning out the required machines, the Ordnance Department can take up the work at that point, and the nation will be assured that the required guns and equipment will be delivered.

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NATIONAL MACHINE TOOL BUILDERS' CONVENTION

The spring convention of the National Machine Tool Builders' Association, which was held at Atlantic City, May 16-17, was, perhaps, one of the most successful spring conventions in the history of the society, and it was certainly the one that brought to Atlantic City the largest number of machine tool builders. The first session, held Thursday morning, May 16, was opened by an address by the president of the association, J. B. Doan, of the American Tool Works Co., Cincinnati, Ohio. An abstract of this address will be found on another page in this number of MACHINERY. Mr. Doan's address was followed by a stirring appeal by Isaac F. Marcosson, a war correspondent who has seen active warfare at all the European fronts, and who particularly warned against too great optimism and against the insidious German propaganda. Maurice T. Fleisher, of Philadelphia, spoke on "Trade Acceptances," and A. Babcock, of the Guaranty Trust Co., New York, spoke on "The Business Survey."

The afternoon session was opened by an address by Admiral R. S. Griffin, engineer-in-chief, U. S. Navy, who spoke on the relations of the Navy Department to the machine tool building trade in general. Admiral Griffin's address was followed by another on the machine tool requirements of the Ordnance Department, by Lieutenant-Colonel H. W. Reed, which is published on another page. Charles T. Foster, of the American Radiator Co., who now serves with the Priorities Board of the National Government, spoke on the subject of "Priority." The meeting was closed with an address by H. E. Miles, chairman of the section on Industrial Training for the War Emergency Council of National Defense, who spoke on the subject "Women in Industry."

Thursday morning an executive session was held, at which George Merryweather, chairman of the Machine Tool Section of the Council of National Defense, made an address on the machine tool requirements of the Government. H. W. Dunbar, of the Norton Grinding Co., Worcester, Mass., also spoke at this meeting on "Safety Devices on Machine Tools." Friday afternoon was devoted to committee meetings.

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SPRING MEETING OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The spring meeting of the American Society of Mechanical Engineers will be held in Worcester, Tuesday, June 4, to Friday, June 7, the headquarters being at Hotel Bancroft. The principal professional sessions will be held on June 5 and 6 at the Worcester Polytechnic Institute. One session on Thursday afternoon will be held at the Norton Co.'s plant, where a paper will be read on the results of a questionnaire upon housing, issued to leading industrial firms, after which an inspection will be made by members of the society and guests of the company's community housing and garden projects. Of special interest will be the so-called "New England sessions," at which papers will be presented upon subjects relating to New England's industries under war conditions, including "Converting a Factory for Munitions Manufacture"; "Training Labor for Shipbuilding"; "The Small Industry in a Democracy," and "Fire Protection." A special session will also be held on industrial safety and workmen's compensation; and another on vocational training. The evening session on Wednesday will be devoted to war subjects, including "Ordnance and Ships for the Navy Department," "Munitions for the Army," and "Aircraft Material." Plants in and about Worcester will also be visited by the members during the convention.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

BULLARD MAXI-MILL

IN the latest addition to the line of boring and turning mills built by the Bullard Machine Tool Co., Bridgeport, Conn., it is claimed that the designers have incorporated all features of Bullard machines of this general type which have been found of practical value since this company built its first machine in 1883. This latest addition to the Bullard line—known as a 61-inch "maxi-mill"—is shown in Figs. 1, 2, and 3, and the remaining illustrations show important features of the design of this new machine. In working out the design of vertical turret lathes, this company has adopted the unit plan of construction, in which the drive, feed works, spindle mechanism, rail construction, lubrication system, etc., are made complete units. These standard features have been incorporated in the present machine, so that, while the machine itself is new, it consists largely of an aggregation of parts which have demonstrated their ability to give satisfactory service under actual conditions of shop operation.

On this machine, a continuous-flow system of lubrication is furnished for oiling all gears, bearings, and spindles, and, in connection with this system, there is a filter which removes all dirt and other foreign matter from the oil, and insures its cleanliness before going back to those members of the machine where lubricant is required. This is the means of avoiding delays due to scored bearings, overheated boxes, and other familiar causes of trouble. All gears and shafts are made of heat-treated chrome-nickel steel. The familiar principle of centralized control is applied, which adds largely to the productive capacity of the machine; and the control clutch and brake for starting and stopping the table are conveniently arranged for the operator, whether he is at the right- or the left-hand side of the machine.

Another important point in enabling this machine to produce work of the desired quality rapidly is the provision of means for effectively delivering a copious flow of cutting lubricant to exactly the required positions on the work and cutting tools, without the possibility of its entrance into the machine. The success of this construction lies in the fact that the machine was designed with this idea in mind, and in this connection it is interesting to note that the experiments which led up to the final form of construction covered a period of four years. Attention is called to the elimination of crank handles, with the object of avoiding danger of accidents in operating a machine where there are high-speed shafts required for obtaining the rapid traverse of heads, etc. The patented "hammer" handwheels used on this Bullard machine put lost motion to good use, and although they eliminate all danger of accidents from operators being struck by rapidly revolving cranks, these hand-

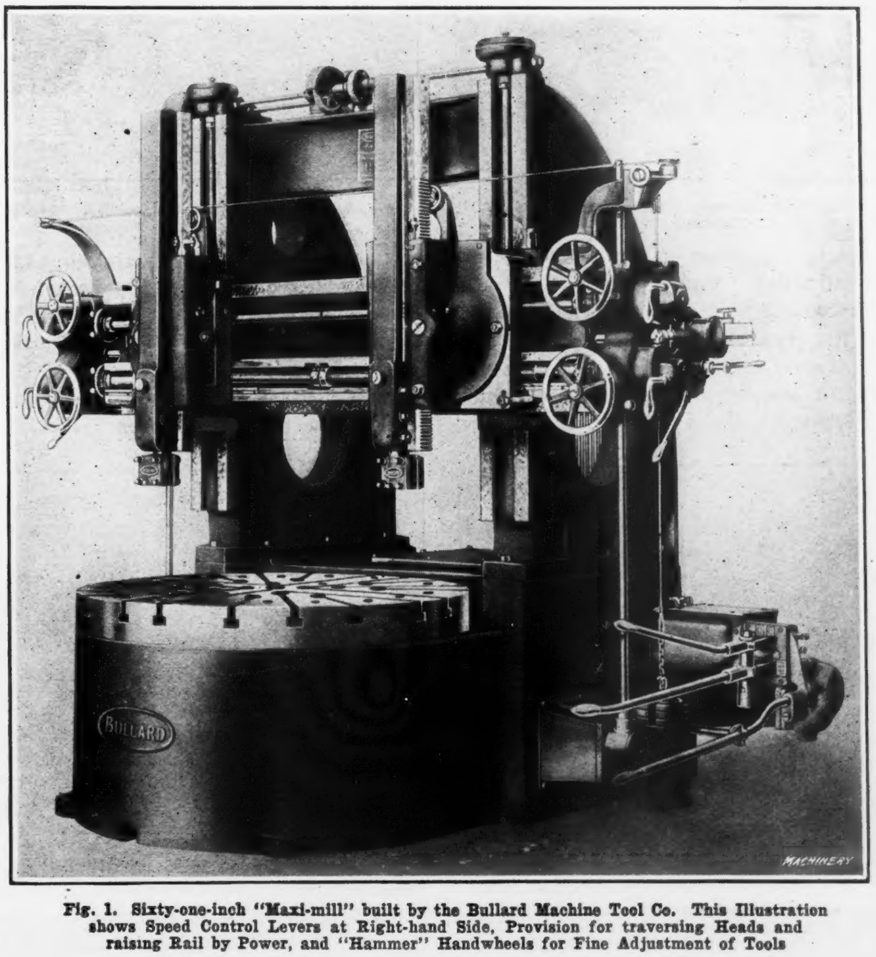


Fig. 1. Sixty-one-inch "Maxi-mill" built by the Bullard Machine Tool Co. This Illustration shows Speed Control Levers at Right-hand Side, Provision for traversing Heads and raising Rail by Power, and "Hammer" Handwheels for Fine Adjustment of Tools

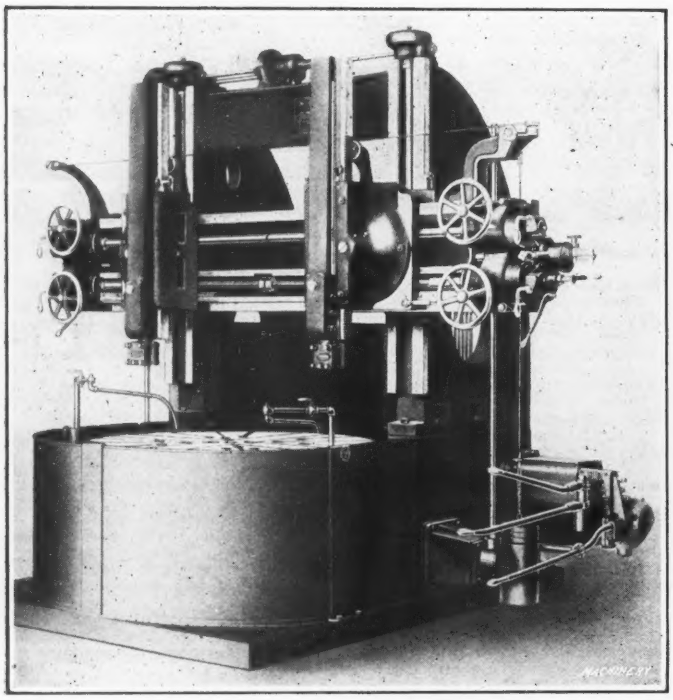


Fig. 2. Arrangement of Cutting Lubricant System on Bullard 61-inch Maxi-mill

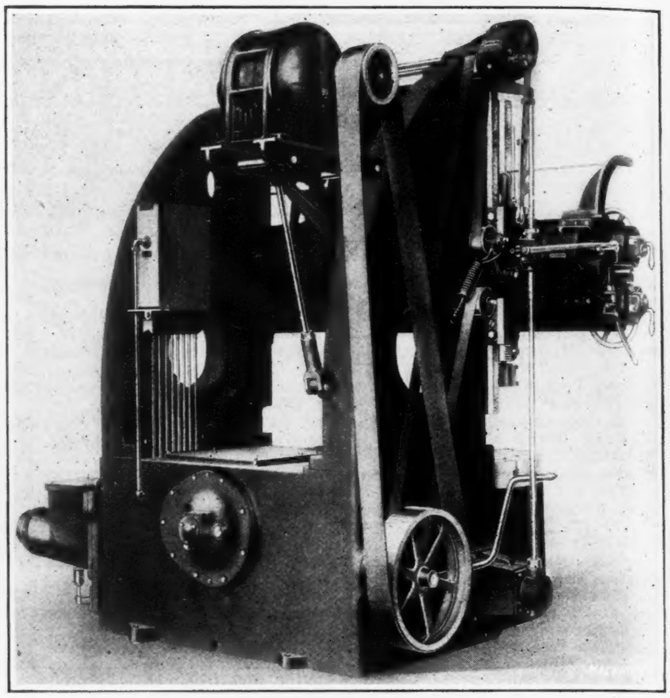


Fig. 3. Arrangement of Continuous-flow Oiling System, Motor Drive, and Left-hand Clutch and Brake Lever

wheels actually increase the operator's ability to obtain fine settings of the tools. Clearly graduated scales are mounted on the face of the cross-rail and on the tool-slides, to give the coarser settings; and micrometer dials, graduated to 0.001 inch and equipped with Bullard "observation stops," afford means of rapidly making finer settings.

Having made a statement of the special features of the Bullard maxi-mill, we are in a position to outline briefly the various details of its construction. The capacity of the machine is for handling work up to 63 inches in diameter by 52 inches in height under the cross-rail and tool-holders. The table is 61 inches in diameter and has parallel T-slots machined in it to provide for the use of four faceplate jaws. Twelve changes of table speed are available, covering a range of from 2.5 to 42.18 revolutions per minute, these changes being obtained by sliding gears and positive friction clutches, which are operated by conveniently located levers that interlock with the clutch and brake lever. The gear-cases in which primary and secondary speed changes are obtained are shown in Figs. 4 and 5, from which a good idea will be obtained of the arrangement of the mechanism. The speed-control levers will also be seen at the right-hand side of the machine in Fig. 1. There are eight changes of feed, covering a range of from 1/96 to 1/2 inch per revolution of the table, either vertical or horizontal. In Fig. 8 is shown the feed works for the right-hand head, and in this illustration a good view will also be obtained of the "hammer" handwheels and arrangement of the power traverse levers.

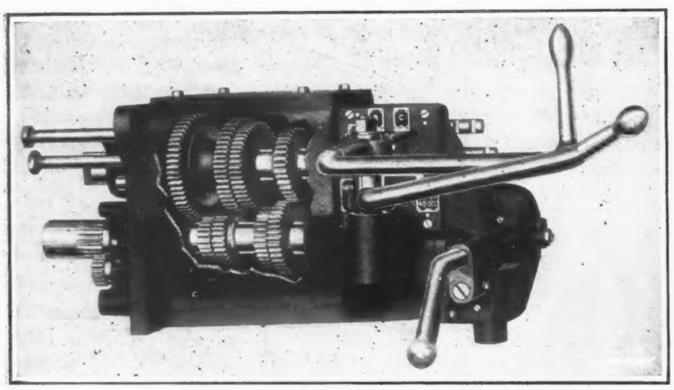


Fig. 4. Primary Speed Change Case, showing Arrangement of Control Levers, Gearing, and Interlocking System

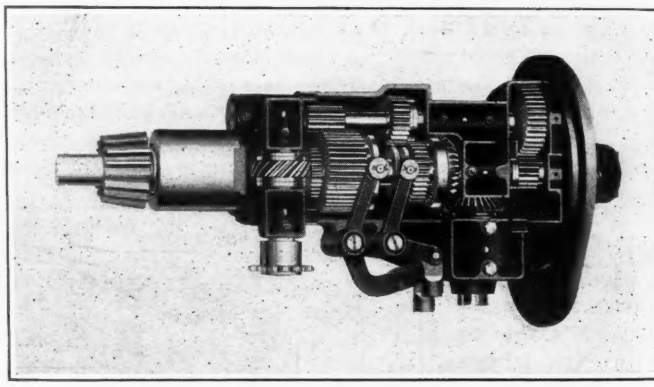


Fig. 5. Secondary Speed Change Case which is designed as a Unit having Ample Power and Durability

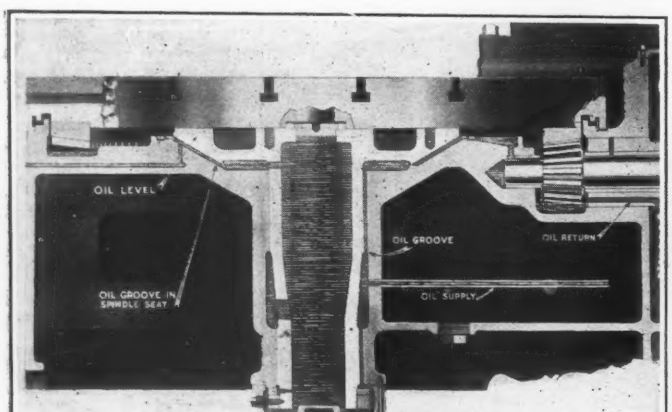


Fig. 6. A Continuous Flow of Oil lubricates the Table Spindle and the Overflow oils the Table Gear and Pinion as well as their Bearings

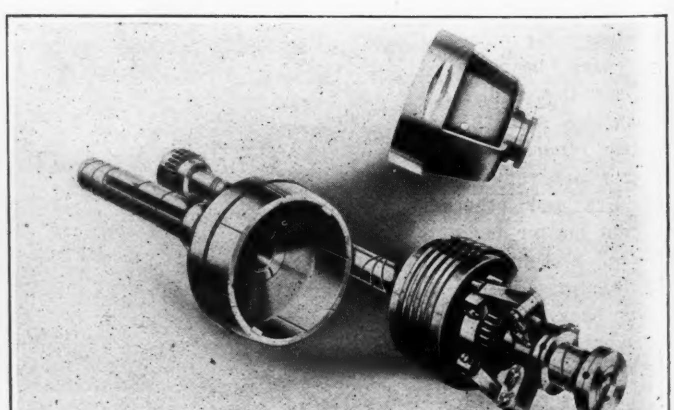


Fig. 7. Parts of the Multiple Disk Clutch and Brake-drum which are kept immersed in Oil to reduce Wear to a Minimum

The tool-slides are made of cast iron of high tensile strength, and they are of box form to give the desired rigidity. Inserted tool-holders are used, and a maximum vertical movement of 36 inches is obtained by means of a rack and pinion adjustment. The tool-holders may be swiveled 45 degrees at either side of the vertical center. All gears and shafts throughout this machine are made of heat-treated, oil-tempered alloy steel, and with the exception of the table driving gear, which is of such dimensions as to preclude the practicability of heat-treatment after machining, all gears are treated in such a way that they have a scleroscope hardness of 70. All bearings and gears having a fixed relation to the bed are lubricated by a continuous-flow system of oiling which is so designed that doubly filtered oil is circulated by a pump connected to the main driving shaft. Thus the pump runs whenever the main driving pulley is in motion.

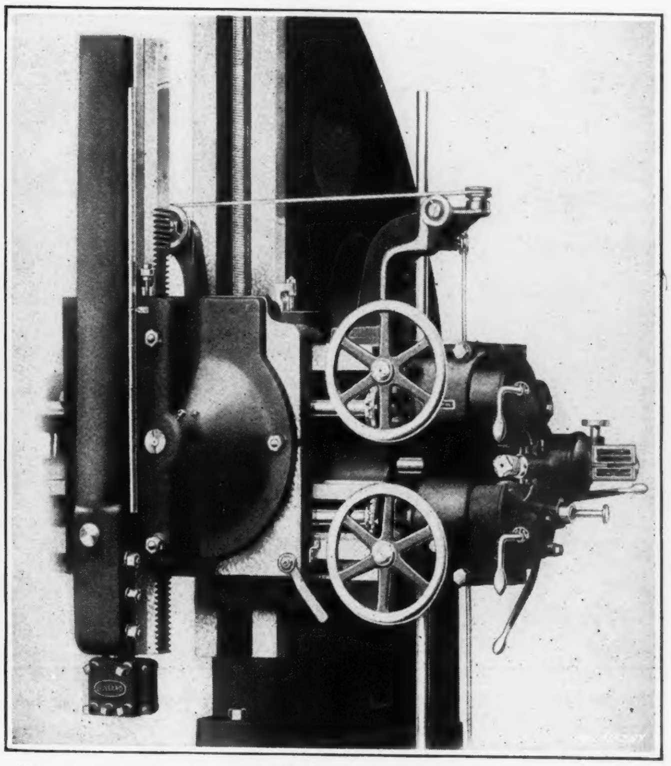


Fig. 8. Arrangement of Right-hand Feed Works, "Hammer" Handwheels, Power Traverse Levers, and Head with Steel Ram

In Fig. 6 is shown the manner in which lubricant is maintained at a constant level beneath the table by a continuous stream of oil which flows into the reservoir; this oil overflows and lubricates the table gear and pinion, as well as their bearings. The way in which oil circulates through this system and the provision made for the lubrication of the table bearing will be apparent from this illustration. All gears are enclosed, although they are readily accessible; the table is guarded, and, as previously mentioned, the use of crank handles and square-end shafts has been eliminated. These safety features go a long way toward eliminating the possibility of injury to the operator. The driving pulley is 24 inches in diameter by 5½ inches face width, and it should run at 405 revolutions per minute. Where motor drive is employed, a 15-horsepower constant-speed motor may be mounted on a bracket at the rear of the machine and connected with a driving pulley by a belt. When equipped with motor drive, this machine occupies a floor space of 11 feet long by 13 feet wide; the minimum height is 9 feet 10 inches, and the maximum height with the bars in their extreme upper position is 10 feet 10 inches; the net weight of the machine is 28,000 pounds.

EXPANDEM BORING TOOL

The Expandem Tool & Mfg. Co., 215-217 W. Superior St., Chicago, Ill., is now manufacturing an expansion boring tool which works on the same principle as a two-jaw chuck. The cutters *A* are so designed that their production is a simple milling machine job, and the threads that are engaged by the right- and left-hand adjusting screw *B* are in the form of oil-hardened steel blocks laid in the cutters. In this way, the cutters are placed under positive screw control for both expanding or contracting, and they are furnished with an absolute micrometer adjustment. In addition, there are what are termed "follow-up blocks" *C*, which are located opposite the cutting edges and directly against the backs of the cutters. As the cutters expand one block follows each cutter, thus supporting them as they come out of the bar. Locking is effected by means of a cam *D*, which comes into direct contact with a clamping pad *E* that is located against the follow-up blocks. It is claimed that these tools lose very little of their rigidity after maximum expansion, and that expansion is not limited to a dead stop, as the cutters can be expanded with absolute safety to 1/16 or even 1/8 inch beyond what is termed the maximum expansion of the tool.

BUFFALO SLITTING SHEAR, PUNCH, AND BAR CUTTER

A No. 25 universal slitting shear, punch, and bar cutter is now being built by the Buffalo Forge Co., Buffalo, N. Y., which has the frame made of armor plate instead of an iron casting, making it possible to provide the same strength for the machine although the weight is only approximately one-sixth of what it would be with the cast-iron construction. In a sense, this machine may be said to represent a war development, because machines constructed with armor-plate frames were formerly imported from Germany. Not only is the weight less,

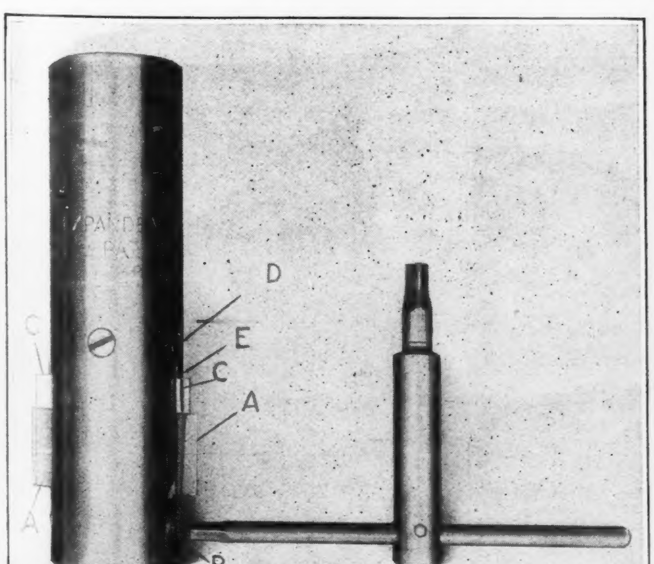


Fig. 1. Adjustable Boring Tool made by the Expandem Tool & Mfg. Co. The Key is shown in Position for adjusting Cutters

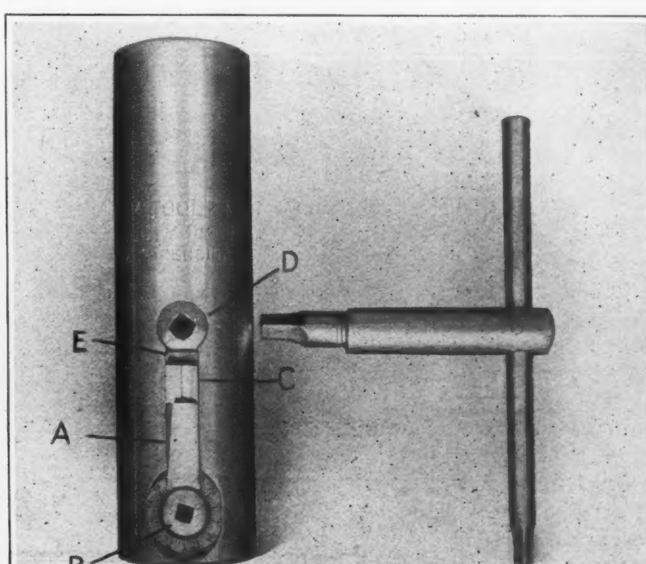


Fig. 2. One End of Key turns Adjusting Screw and the Other End tightens Binder after Cutters have been set in the Desired Position

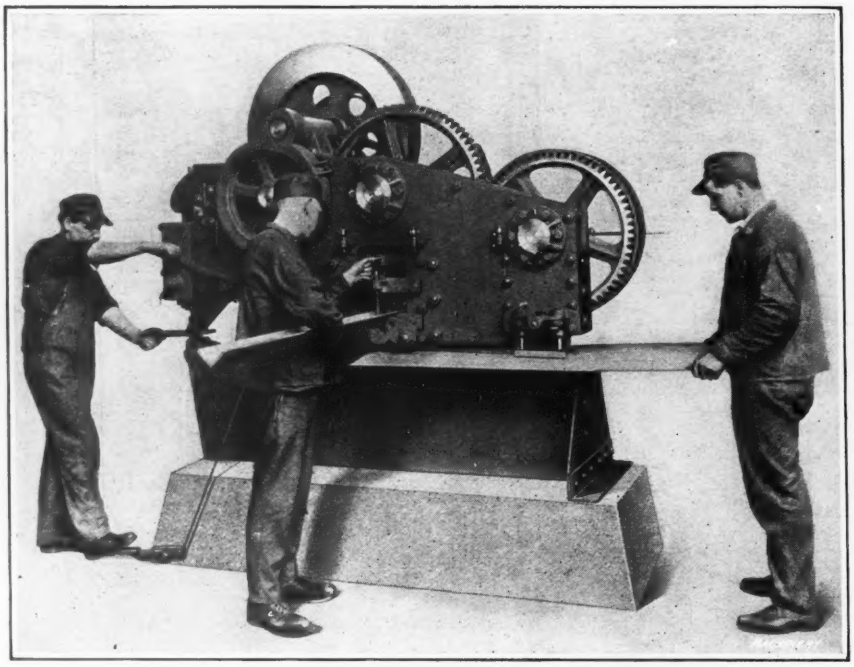


Fig. 1. No. 25 Combination Slitting Shear, Punch, and Bar Cutter built by the Buffalo Forge Co. The Frame is made of Armor Plate

but it is possible to make machines of much more compact design for a given capacity. The present machine is a universal slitting shear, punch, and bar cutter, which is an unusual combination. A shear with capacity to slit plates of any width or length is combined in a single unit with a punch having capacity for handling sheets, channels, I-beams, and other special sections, and a bar cutter for cutting angles and tees, either square or miter. By the substitution of special knives provision may be made for cutting channels, beams, and other rolled sections. Three distinct operations can be performed on this machine without in any way interfering with each other. It will be apparent that the machine is operated by either a foot-treadle or hand-lever, and three members of the machine may be operated independently or simultaneously.

Each of the members of this universal machine runs at twenty-five strokes per minute, and the capacities are as follows: Shear: Plates up to 5/8 inch in thickness and flats up to 3/4 by 3 inches. The length of knives is 8 inches. Bar cutter: Angles cut square, up to 1/2 by 4 inches; angles cut mitered, up to 5/16 by 2½ inches; T-irons, up to 3/8 by 3½ inches; round bars, up to 1½ inch in diameter; square bars, up to 1¼ inch; I-beams and channels, up to 6 inches. Punch: Holes up to 1 inch in diameter in plates up to 5/8 inch thick. The height of stroke is 1 inch.

This machine may be built for either individual motor drive or belt drive. All gears are machine-cut from steel blanks and the pinions are cut from solid manganese steel blanks. All bearings are of ample proportions and provided with bronze bushings, the high-speed shaft being carried in ring-oiled bearings. On the punch end, in addition to the gag operated either by foot or hand, there is a second gag with a handle which is used in place of the customary handwheel to provide for bringing the punch down onto the work without penetrating the material. This provides for locating center marks and also for setting up dies and punches. The shear is engaged by a jaw clutch and the stripper is readily adjusted in place by two spiral gears operated through a crank and pinion. In the illustration of the bar cutter section, there are shown the adjustable stops, which can be moved to the right or left to provide for cutting mitered ends. The design has been worked out in such a way that the operation of the machine is quite simple. Where the machine is motor-driven, a 5-horsepower motor is required, although it is recommended to use a motor developing 7½ horsepower. The high-speed shafts run at 350 revolutions per minute.

FRANCO TOSI SHELL LATHE

In the accompanying illustrations there are shown two views of a special lathe developed by Franco Tosi of Legnano, Italy, for use in machining 10-inch and 12-inch shells. These lathes were originally developed by this firm for its own use in filling shell orders secured from the Italian Government, but the machines have proved so successful in operation that it was recently decided to build them for the market. An office is maintained at 82 Wall St., New York City, for handling sales in this country. To men who are familiar with the design of standard engine lathes and single-purpose shell lathes built in the United States, it will at once become apparent that the design of this machine has been worked out along decidedly different lines. The shell is chucked in a central geared head and a series of turret tools are used for performing machining operations on the nose of the shell.

The base of the shell projects through the back of the geared head, thus providing for simultaneously performing machining operations on the base. For this purpose, it will be seen that a cross-slide is mounted at this end of the lathe bed and that it carries two square turret heads. These heads are furnished with tools used for facing off the base of the shell, turning the band seat, and performing other operations that are required. To give an idea of the high rate of production that is

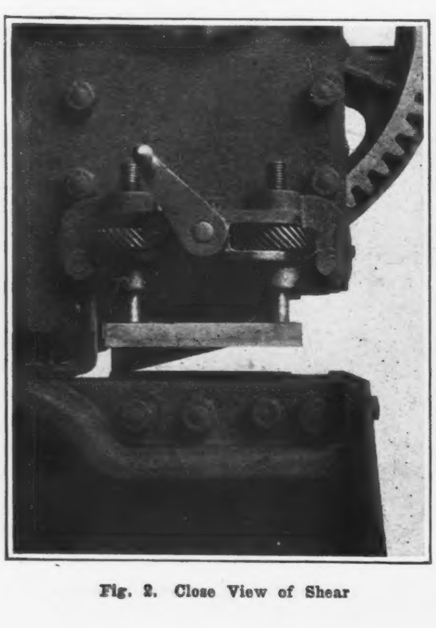


Fig. 2. Close View of Shear

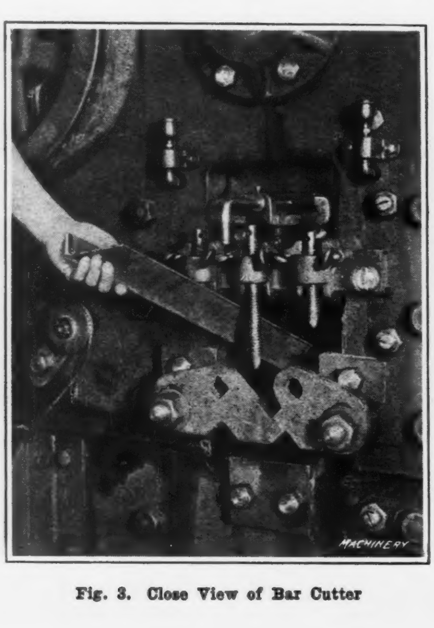


Fig. 3. Close View of Bar Cutter

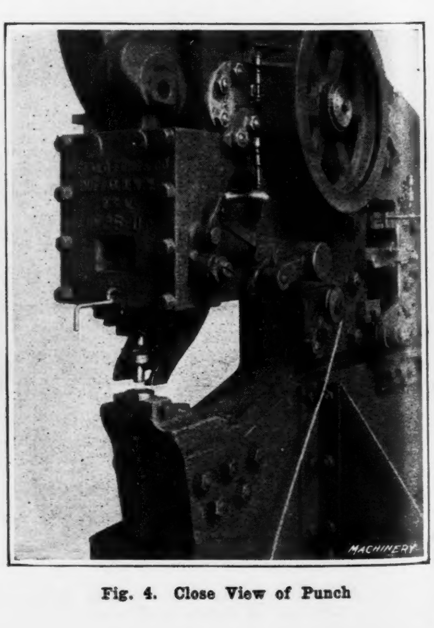


Fig. 4. Close View of Punch

made possible through the simultaneous performance of machining operations on both ends of the shell, it may be mentioned that the National Radiator Co., of Brescia, is using five of these lathes for machining 260-millimeter shells and is turning out 200 shells per day. As another example of production, it may be mentioned that this company has machined 260-millimeter shells in 22 minutes, which certainly represents an excellent rate of production.

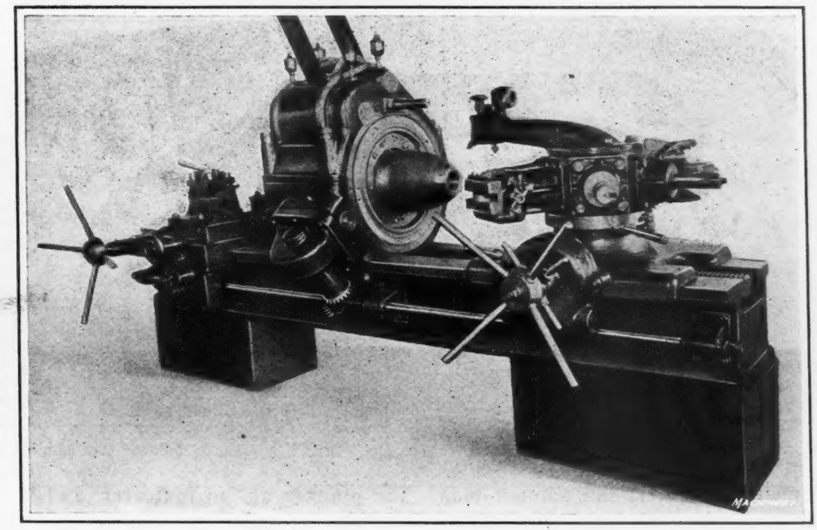


Fig. 1. Franco Tosi Shell Lathe, showing Turret carrying Tools for Working on Nose of Shell

At the beginning of the war, this company studied the requirements of machining operations on large shells and designed this special lathe for handling the work. Fifty of the lathes were built and installed in the ammunition department, and it is said that they have run for over two years without giving any trouble. These machines are belt-driven and a forward speed of 270 revolutions per minute and a reverse speed of 210 revolutions per minute are available. The machining operations performed are as follows: On the front end of the shell the nose hole is bored and threaded, the nose of the shell is machined to the required form, and the insulating ring is also turned, automatic and hand carriage movement being employed in operating the tools used for these purposes. At the opposite end of the shell, the operations are: turn flat bottom; turn copper band seat, and machine "waves" in band seat.

The principal dimensions of this machine are as follows: swing, 12 inches; length of bed, 10 feet 7½ inches; inside diameter of shell-holder, 12 13/64 inches; length of head, 18 45/64 inches; maximum distance between head and square turrets, 19 11/16 inches; maximum distance between head and front turret head, 35 7/16 inches; maximum stroke of square turrets, 23⅝ inches; maximum stroke of front turret, 33 29/64 inches; and weight of machine, 8800 pounds.

LEA THREAD LEAD TESTER

For use in testing the lead of thread gages and other parts where a high degree of accuracy is required, the West & Dodge Co., 167 Oliver St., Boston, Mass., is now building a special form of lead tester, which is shown in use in the illustrations which accompany the following description. This machine was developed by Charles Lea, of the West & Dodge Co. Figs. 1 and 2 show front and rear views of this apparatus set up for testing the lead of a thread gage, and the best idea of the way in which the work is handled will be gathered from these illustrations. It will be seen that the thread gage is supported between centers and that a plug which is accurately ground at the point to fit the threaded work is supported by an arm at the back of the machine. This arm is carried on a slide, so that its position may be adjusted for handling any work which comes within the range of the machine, and the holder in which the plug is carried has rack teeth milled on its under side to engage a pinion that is turned by means of a knurled thumb-screw. In this way the position of the holder may be adjusted to bring the point of the plug into position for handling threaded work of any diameter up to 6 inches; the machine also has a capacity for handling work up to 6 inches in length. Attention is called to the fact that when the lead tester is in use, the arm which supports the pointed plug that engages the thread to be tested is securely clamped to the slide, and the holder in this arm is also clamped in position. When it is desired to change the pointed plug from one thread to another on the work, this is accomplished by drawing the plug back in the holder by means of the small knurled extension which will be seen at the top of the holder in the rear view of the machine.

At the end of the machine there is a Brown & Sharpe micrometer head which had a large graduated wheel mounted on it so that readings may be accurately taken to 0.0001 inch. The spindle carried by the micrometer head is extended to engage the plunger of a B. C. Ames dial test indicator, and after the pointed plug has been set in position in a thread, the micrometer spindle is advanced to engage the indicator, after which the reading of the indicator is carefully noted. It may be considered desirable to set the indicator needle back to the zero position on the dial after the plunger has been engaged by the micrometer spindle, although this is not really necessary. The next step is to withdraw the pointed plug from the thread and move the plug along so that it may be entered into the adjoining thread or the second or third thread from the one in which the point was originally placed. Referring to the rear view of the machine, it will be seen that the arm which carries the micrometer head and the arm which carries the pointed plunger that engages the threaded work are both carried on a sliding bar. Emphasis is laid on the fact that both of the arms carrying the mechanism are rigidly clamped to the dovetail slide at the top of this bar, so that the bar itself moves on the bed of the machine, carrying these two members with it, just as if the bar and the arms that are carried by it were a single piece.

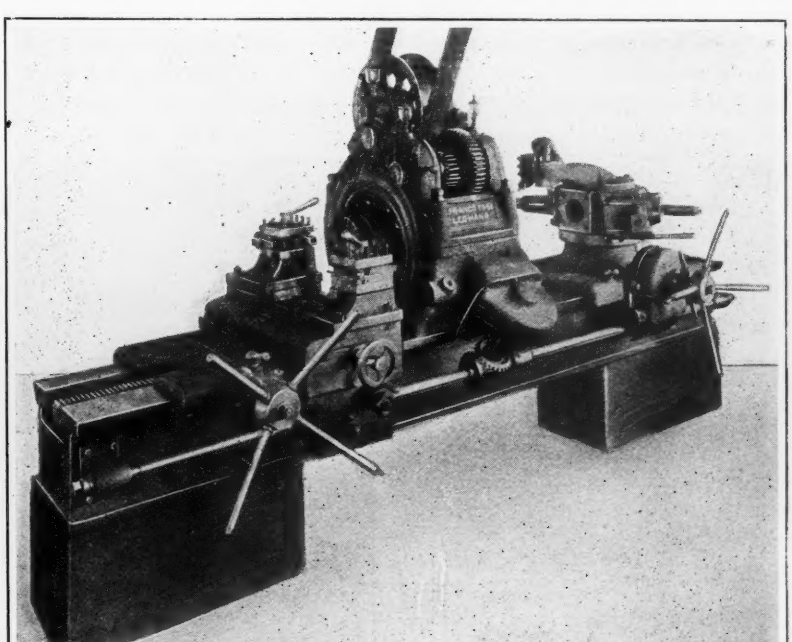


Fig. 2. Franco Tosi Shell Lathe, showing Turret carrying Tools for working on Base of Shell

After the pointed plunger has been reengaged with the threaded work, the micrometer spindle is again advanced into contact with the indicator point and screwed up until the needle of the indicator comes back to the same position which it occupied

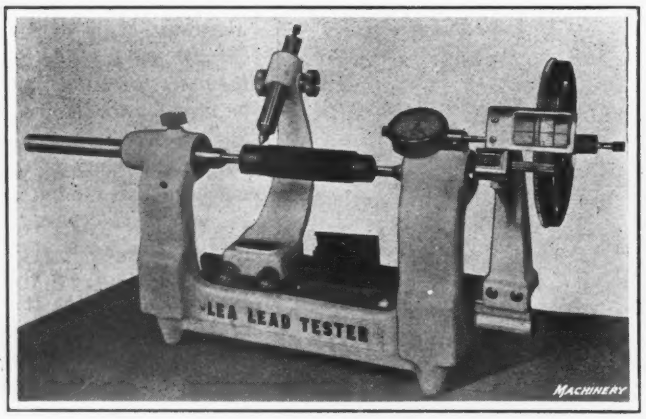


Fig. 1. Lea Thread Lead Tester built by the West & Dodge Co.

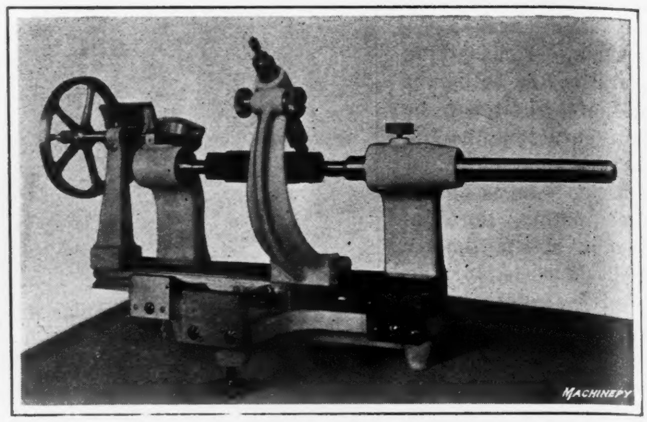


Fig. 2. Opposite Side of Lea Thread Lead Testing Machine

after the first setting was made. Then, if the pointed plug was engaged with the next thread on the work, the difference in readings of the micrometer head between the first and second settings should correspond with the lead of the thread, provided there is no error. In case the point was entered into the second or third threads from the one in which it was originally placed, the micrometer reading should be two or three times the lead, as the case may be. It will be seen that the large graduated dial on the micrometer head has gear teeth cut around it meshing with a long-faced pinion that transmits movement to an automatic counter made by the Veeder Mfg. Co. This counter is arranged so that it records each interval of 0.0001 inch, thus making the apparatus direct-reading and saving the time which would be required in taking readings of the micrometer. As a result, it is possible to test threaded work very rapidly with an apparatus of this kind, and the method of operation is so simple that the use of this lead testing machine can be safely entrusted to girls.

When so desired, Johansson Swedish gage-blocks may be used in connection with this machine for checking the accuracy of the lead of any threaded work. Figs. 3 and 4 show two possible methods of procedure. As shown in Fig. 3, a gage-block is used, the thickness of which represents some exact multiple of the lead of the thread. The pointed plunger is introduced into one thread on the work, after which the micrometer head is screwed up against the gage-block which is introduced between the micrometer spindle and the plunger of the dial test indicator. The reading of the indicator is then taken, and if it is considered necessary, the needle may be set back to the zero point. The next step is to lift the pointed plunger out of engagement with the work and move it along so that it may be entered into a groove separated from the groove in which the first setting was made by a number of threads that is equal to the multiple which the gage-block is of the thread lead. The micrometer spindle is then directly in contact with the plunger of the indicator, and it should bring the needle back to the same position which it occupied for the original setting. If there is any error in the lead of the thread, this is indicated by the micrometer when the indicator has been brought back to the required position. It will be apparent that by this method the Johansson gage constitutes a distance piece and saves time which would otherwise be required to screw the micrometer spindle through a considerable distance each time the change of setting was made.

By the other method of using a Johansson gage-block, the dial test indicator is dispensed with and a fixed stop substituted in its place, as shown in Fig. 4. The pointed plunger is introduced into a groove in the threaded work, and the micrometer spindle is then screwed up to just come into contact with a gage-block held against this fixed stop. After this has been done, the micrometer reading is noted and the pointed plunger is moved over and introduced into the proper thread, so that, with the Johansson gage-block removed, the fixed stop and micrometer spindle will be in contact. If there is any error in lead, this is indicated by the micrometer reading when screwed up into contact with the gage-block. As an alternate method, the micrometer spindle can be locked and the testing done with Johansson gage-blocks, using the dial indicator to determine the amount of error.

ECONOMY SCRAP METAL BALER

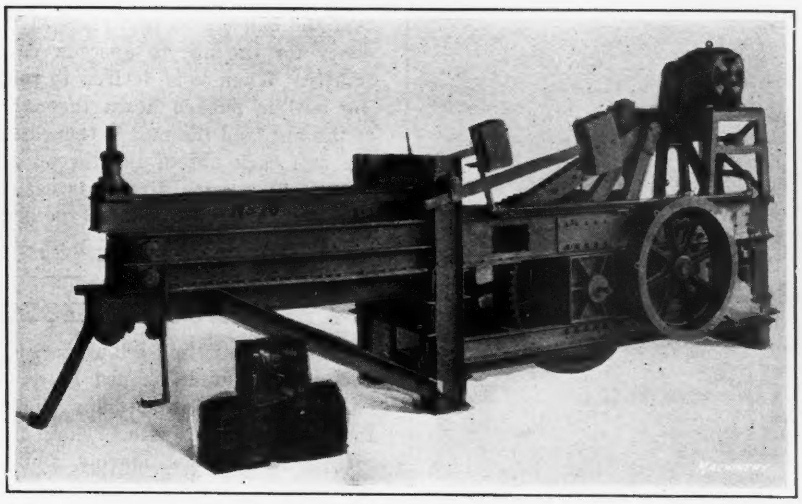
For use in compressing scrap sheet metal, punch and stamp skeletons, wire, metal trimmings, etc., into compact bales ready for shipment, the Economy Baler Co., Ann Arbor, Mich., has developed a mechanically operated baling press, which is illustrated and described herewith. Machines of this type may be built to special order for producing any desired size of bale, in addition to the two standard sized machines, which produce bales 10 by 10 inches by any third dimension up to 16 inches, and 6 by 12 inches by any third dimension. The first machine,

Fig. 3. Use of Johansson Swedish Gage-blocks with Micrometer and Dial Test Indicator

Fig. 4. Use of Johansson Swedish Gage-blocks with Micrometer and Fixed Stop in Place of Indicator

to which reference has just been made, is usually built to produce bales measuring 10 by 10 by 10 or 10 by 10 by 12 inches, which weigh from 75 to 100 pounds. The second machine is used chiefly for baling scrap copper, brass, and similar metals, and is usually made to produce a bale 6 by 6 by 12 inches in size.

One of the chief claims made for this machine is that it is designed to be operated by one man, and that it is equipped with an automatic "bale kicker" which automatically removes the finished bale from the machine. Approximately fifteen seconds is required to compress a charge of scrap sheet metal. The feeding box is 5 feet long, so that ample capacity is provided to enable work to be thrown in promiscuously without the necessity of cutting up or folding long pieces. It will be of interest to note that machines of this type have recently been adapted for use in the United States Mint at Philadelphia. When so desired, the machine can be sunk to bring the top of the compression box level with the floor line.



Machine built by Economy Baler Co. for use in baling Scrap Sheet Metal

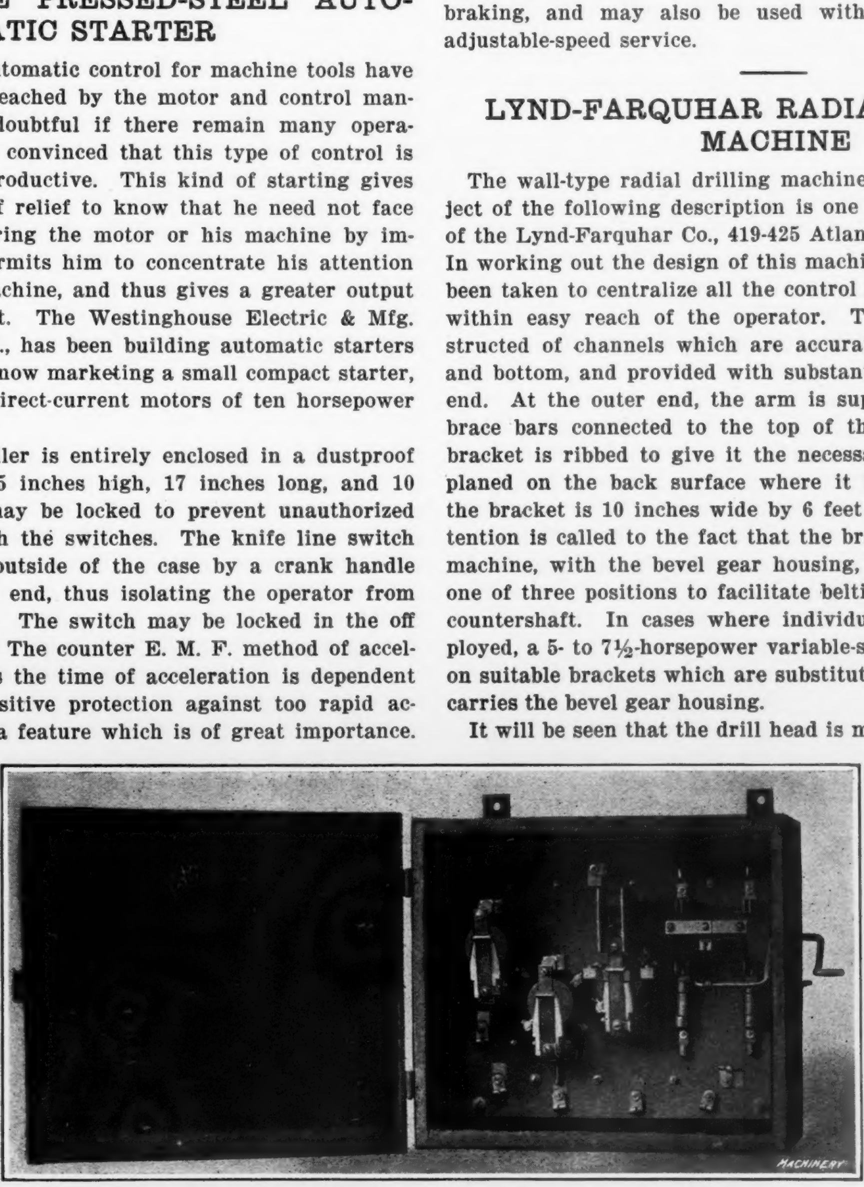
WESTINGHOUSE PRESSED-STEEL AUTOMATIC STARTER

The advantages of automatic control for machine tools have been so persistently preached by the motor and control manufacturers that it is doubtful if there remain many operators who are not fully convinced that this type of control is both economical and productive. This kind of starting gives the operator a sense of relief to know that he need not face the possibility of injuring the motor or his machine by improper starting. It permits him to concentrate his attention on the work on his machine, and thus gives a greater output of the finished product. The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been building automatic starters for many years, and is now marketing a small compact starter, specially adapted for direct-current motors of ten horsepower and less.

The complete controller is entirely enclosed in a dustproof case (approximately 15 inches high, 17 inches long, and 10 inches deep), which may be locked to prevent unauthorized persons tampering with the switches. The knife line switch is operated from the outside of the case by a crank handle extending through one end, thus isolating the operator from current-carrying parts. The switch may be locked in the off position if so desired. The counter E. M. F. method of acceleration is used, and as the time of acceleration is dependent on the motor load, positive protection against too rapid acceleration is assured—a feature which is of great importance.

Experience has shown that in all ordinary service, motors up to fifteen horsepower require only two points of acceleration, and these are obtained in this starter by the use of only one accelerating contactor. Where the starting is exceptionally heavy, as in the case of machine tools with large flywheels, positive pressure blowers, or long lineshafting, two accelerating contactors are used, giving three points of acceleration. The main parts of the contactors are made of pressed steel, thus combining great strength, uniformity, and light weight. Provision is made for either conduit or open wiring, through the top, bottom, and end of the case, opposite the switch handle.

These starters are provided with protection against failure of power, and may be so arranged that either the motor will be started again when the power returns or it will require the service of the operator to start it. The latter arrangement is used for machine tools and similar applications where the unexpected starting of the machine might cause injury to the mechanism or to the operator. The former method is applicable where it is desired to have as little interruption of the service as possible, as in the case of pumps, compressors, and similar services. By using pressure gages, or other automatic devices in connection with these starters, automatic service may be obtained, and continual operation provided, without any attendant. They are built both with and without provision for dynamic braking, and may also be used with a field rheostat for adjustable-speed service.

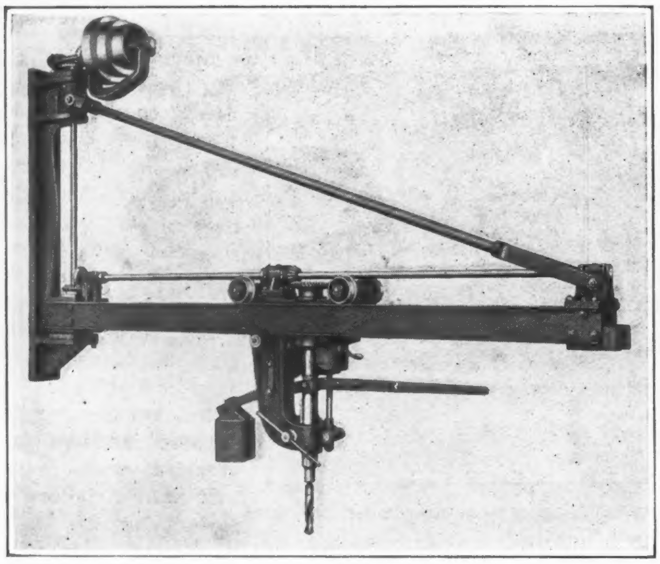


Pressed-steel Automatic Starter made by Westinghouse Electric & Mfg. Co.

LYND-FARQUHAR RADIAL DRILLING MACHINE

The wall-type radial drilling machine which forms the subject of the following description is one of the recent products of the Lynd-Farquhar Co., 419-425 Atlantic Ave., Boston, Mass. In working out the design of this machine, particular care has been taken to centralize all the control levers so that they are within easy reach of the operator. The radial arm is constructed of channels which are accurately planed at the top and bottom, and provided with substantial supporters at each end. At the outer end, the arm is supported by heavy steel brace bars connected to the top of the wall bracket. This bracket is ribbed to give it the necessary strength, and it is planed on the back surface where it is bolted to the wall; the bracket is 10 inches wide by 6 feet 10½ inches high. Attention is called to the fact that the bracket at the top of the machine, with the bevel gear housing, can be located in any one of three positions to facilitate belting the machine to the countershaft. In cases where individual motor drive is employed, a 5- to 7½-horsepower variable-speed motor is mounted on suitable brackets which are substituted for the bracket that carries the bevel gear housing.

It will be seen that the drill head is mounted on four flanged wheels, which are fitted with roller bearings, so that it moves very easily along the arm. All gears are accurately cut from solid blanks, and the feed-gears are made of steel. All bearings are lined with bronze bushings, which may be easily renewed when necessary. The hand-feed lever is counterbalanced by an adjustable weight and can

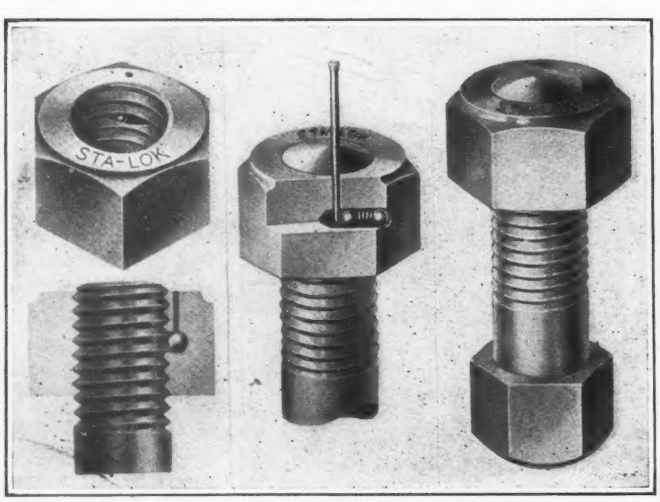


Wall Type of Radial Drilling Machine built by the Lynd-Farquhar Co.

be regulated to remain in any position. Two changes of power feed are available at the rates of 0.015 and 0.025 inch per spindle revolution. These feeds can be changed while the machine is running. Automatic release of the power feed is provided at the extreme limit of the spindle traverse, to avoid danger of damaging the mechanism. The spindle is made of high-carbon steel; it is 2½ inches in diameter in the bearings and accurately finished to size by grinding. Renewable bronze bearings of ample size support the spindle, which has a maximum traverse movement of 7 inches and is bored with a No. 4 Morse taper hole. The spindle thrust is carried by a ball bearing. When the spindle has been located in the desired position for drilling, a clamping lever secures the head in place on the arm. Tie-bar lugs are provided at the extreme end of the arm to receive tie-bars, in the event that their use should be found desirable when performing exceptionally heavy drilling operations. The countershaft is equipped with tight and loose pulleys, 16 inches in diameter by 4½ inches face width, which are run at 350 revolutions per minute, and this countershaft is furnished with means of automatic lubrication.

EVERTITE "STA-LOK" NUT

A lock-nut is manufactured under the trade name of "Sta-lok" by the Evertite Nut Corporation, Marquette Bldg., Detroit, Mich., which is claimed to be so constructed that it will not loosen under heavy stress or prolonged vibration in high-speed machinery. This nut has the same appearance as an ordinary nut, but reference to the accompanying illustration, which shows the interior mechanism, will make the provision for locking the nut quite apparent. Contained in the body there are two hardened steel balls with a compression spring between them, and when the nut has been screwed up, the spring forces one of these balls inward through a channel, so



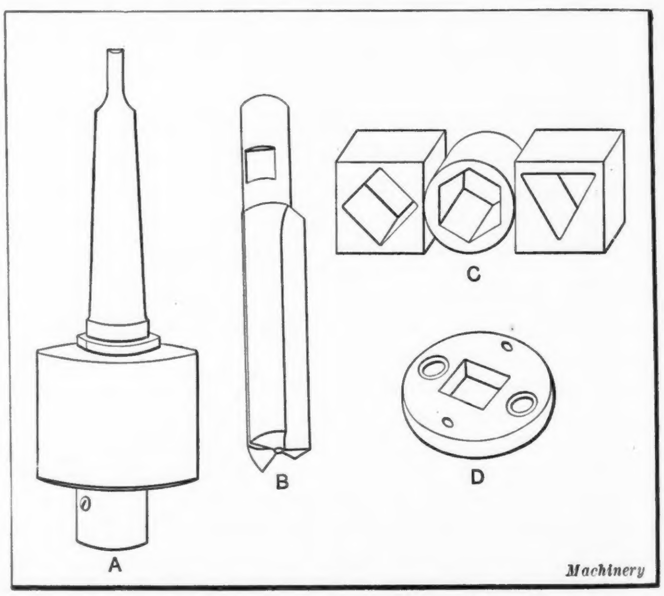
Evertite "Sta-lok" Nut, showing Principle of locking and Method of releasing Nut

that the ball comes into place in the thread groove. Any tendency for the nut to unscrew causes this ball to bind more tightly. When it is desired to release the nut, a small finishing nail is pushed down through a hole drilled in the top of the nut, and the nail is tapped lightly to provide for forcing the ball back out of the thread groove. Should the keyhole become filled with dirt, it is easily cleaned out with a small wire or pin. Nuts of this type are manufactured and carried in stock in various sizes in U. S. and S. A. E. standard threads.

WATTS ANGULAR-HOLE DRILLING TOOLS

For use in drilling triangular, square, hexagonal, octagonal, and other angular shaped holes, Watts Bros., Turtle Creek, Pa., are now manufacturing the tools which are illustrated and described herewith. These tools are adapted for use in cutting metal, wood, marble, and other materials, and enable the work to be done in a very small fraction of the time that is required to cut holes of these shapes by other methods. They can be used in a drilling machine where the tool is revolved or in a lathe where the work is revolved. This method is not adapted for cutting deep holes.

In operation, the drilling tool is held in a floating chuck *A*, which is provided with a standard Morse taper shank to fit the socket in a machine tool spindle. This chuck is universal in its scope, and it is so designed that provision is made to prevent breaking tools or producing bell-mouthed holes. The



Tools made by Watts Bros. for Use in drilling Triangular, Square, Hexagonal, and Similar Shaped Holes

form of tool *B* which is used depends upon the shape of hole that it is desired to drill, and a guide *D* corresponding to the shape of the hole is clamped on the work. The range is for cutting holes from 1/4 inch square, hexagon, octagon, etc., across the flange up to any size which may be required.

In order to explain the way in which the operation is performed, suppose that a square chuck wrench or hexagon socket wrench is to be made. After the wrench body has been machined, a guide-holder of the proper shape with the guide inserted is placed in position on the work and securely fastened. The drill is introduced into this guide and the machine is started. The guide is made of the same shape and size as the hole to be drilled, and so controls the movement of the tool that it exactly duplicates the form of the hole in the guide. Where there are a number of pieces to be drilled, it will usually be found desirable to make a jig furnished with guide bushings of the desired form. In sharpening the drills, care should be taken to grind the cutting lips square with the sides and to provide a 7-degree clearance back of the cutting edge.

AUTOMATIC ROUTING MACHINE FOR FIRING PIN PLUGS

The time fuse firing pin plug illustrated on an enlarged scale in Fig. 1 requires two grooves or channels, as the end view shows. The automatic machine to be described is for

routing these grooves. When the machine is in operation the work is given an oscillating movement equal to the length of one groove, and the routing operation is performed by a small "fishtail" cutter, which advances to the proper depth. When the first groove is finished and the cutter has withdrawn to clear the work, the latter is indexed one-half revolution. The oscillating movement then continues while the second groove is being cut. As soon as the routing operation is completed, the cutter withdraws and the machine stops. After the work is placed on the spindle and the machine is started by lifting the starting lever into engagement with a catch, all movements such as the traversing action of the cutter-slide, indexing, and stopping the machine are controlled automatically.

The machine is driven by two belts, there being one for the cutter-spindle and another for the operating mechanism. The work-spindle consists of an inner and outer section, and when the cutter is at work, the outer section is locked in position by a pawl while the inner part receives an oscillating movement. The latter motion is derived from a crank *A* (see Fig. 2) which connects by the rod shown with a pin attached to disk *B*. Crank *A* is mounted at the end of shaft *C*, Fig. 3, from which all the motions of the machine are derived except the rotation of the cutter-spindle. After the first channel has been routed and just before the machine indexes, the outer section of the work-spindle is unlocked, and this part is turned one-half revolution while the inner section is held stationary by the action of a clutch.

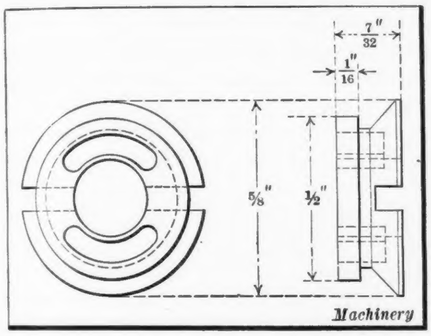


Fig. 1. Firing Pin Plug upon which Routing Operation is performed

After a plug has been placed over the expanding arbor and clamped by the operator, the starting lever is lifted into engagement with the catch and the cutter-slide is advanced by cam *D*, which is driven through worm-gearing from shaft *C*. This cam engages a lever *E*, which, in turn, is connected to the cutter-slide. This is not a direct connection, as the end of the lever engages a supplementary slide, the position of which is controlled by screw *F*, which serves to regulate the lengthwise position of the cutter and the depth of the groove formed in the work. When the first groove is completed and the cutter has withdrawn, a cam located back of cam *D* lifts the end of a lever *G*, which, in turn, unlocks the outer section of the work-spindle. This movement of *G* through suitable connecting levers at the end of the machine (see Fig. 2) also serves to shift a clutch from the oscillating disk *B* over into engagement with the inner spindle, which is thereby locked

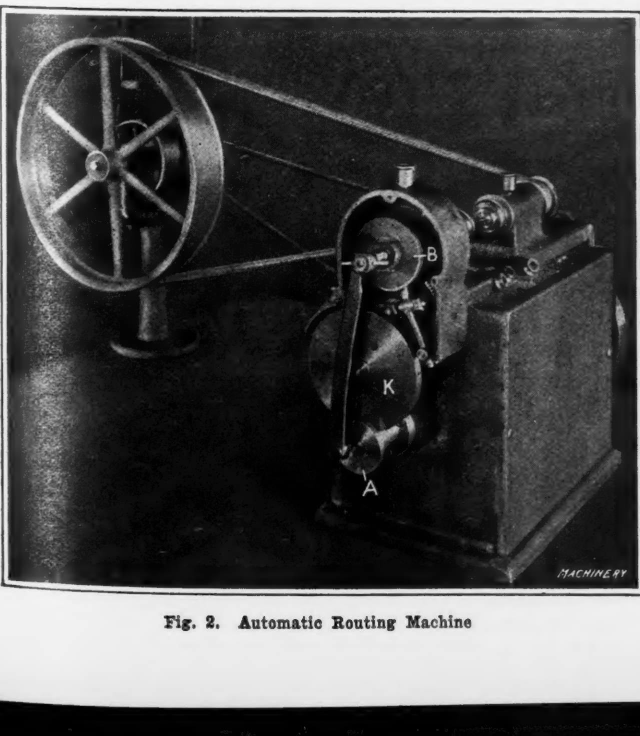


Fig. 2. Automatic Routing Machine

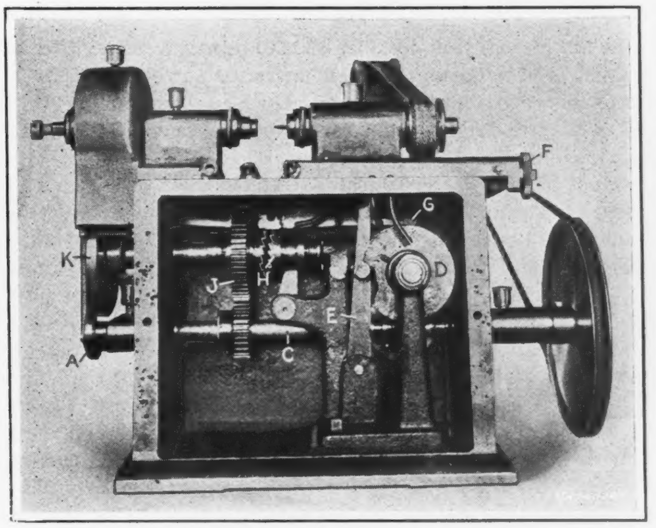


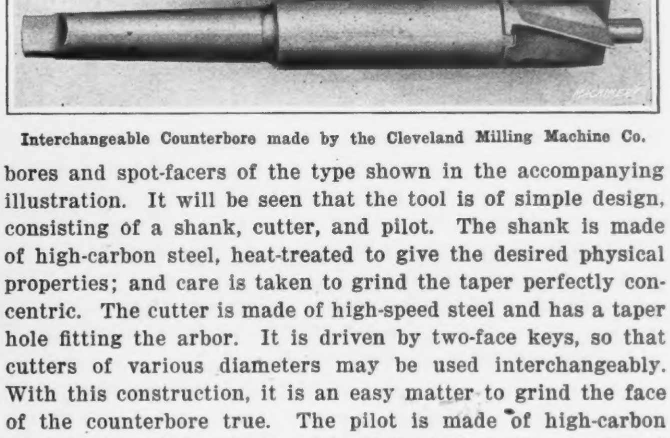
Fig. 3. Cover removed to show Mechanism of Automatic Routing Machine

in place temporarily. As soon as the motions referred to have occurred, clutch *H* is thrown into engagement with gear *J*, which revolves freely on its shaft except during the indexing movement. The action of clutch *H* is derived from a bell-crank lever having a pin that drops into a notch formed in the cam which operates lever *G*. The engagement of clutch *H* causes disk *K* to revolve, and this disk carries a pin that engages a notch in a Geneva wheel. This wheel is thus caused to turn one-quarter of a revolution, and it is connected by 2 to 1 gearing with the outer spindle; consequently, the latter is revolved one-half a revolution, which is the required indexing movement.

One operator can easily attend to three of these machines and the production of each machine is about 200 parts per hour when the cutter-spindle is revolving 15,000 revolutions per minute. This machine is manufactured by the Automatic Engraving & Mfg. Co., 79 E. 130th St., New York City, and it was designed by E. A. Lundvall, vice-president of the company.

CLEVELAND COUNTERBORES

The Cleveland Milling Machine Co., Cleveland, Ohio, has recently placed on the market a line of interchangeable counter-



Interchangeable Counterbore made by the Cleveland Milling Machine Co.

bores and spot-facers of the type shown in the accompanying illustration. It will be seen that the tool is of simple design, consisting of a shank, cutter, and pilot. The shank is made of high-carbon steel, heat-treated to give the desired physical properties; and care is taken to grind the taper perfectly concentric. The cutter is made of high-speed steel and has a taper hole fitting the arbor. It is driven by two-face keys, so that cutters of various diameters may be used interchangeably. With this construction, it is an easy matter to grind the face of the counterbore true. The pilot is made of high-carbon steel, heat-treated and ground to fit the hole in the shank and cutter, and it is designed in such a way that any diameter of pilot may be used with any diameter of cutter, changes of pilots and cutters being quickly made. The pilot is ground 0.0015 inch smaller on the diameter than the specified size.

FOSTER UNIVERSAL TURRET LATHE

In the March, 1917, number of MACHINERY, a description was published of a Foster Type 1B universal turret lathe. In the accompanying illustrations, is shown a combination turret lathe adapted for handling both bar and chucking work; this is styled a No. 2B universal machine, and it is the latest product of the Foster Machine Co., Elkhart, Ind. This machine is of quite similar design to the one previously described, and the following description will be chiefly devoted to describing those features which are different. The machine is adapted for handling bar work up to 3¼ inches in diameter by 30 inches in length, and chucking work up to 13 inches in diameter can be machined. Owing to the larger swing over the horns of the carriage, this lathe is able to handle light chucking work up to 20 inches in diameter. A belt 4 inches in width running over a single pulley, 15 inches in diameter, drives the machine, and for high-speed steel cutting tools, this driving pulley runs at 500 revolutions per minute. When stellite tools are used, a higher cutting speed is required, and it is recommended that the pulley be driven at 750 revolutions per minute. With the belt running at a speed of 1960 feet per minute, 8½ horsepower is delivered to the machine, which corresponds to a torque at the spindle nose of 43,000 inch-pounds with the spindle running at 12 revolutions per minute. The reason for this apparently excessive power of the head is that this machine is frequently required to take as many as four or five cuts simultaneously with a comparatively coarse feed, and ample power is provided for handling severe service of this character.

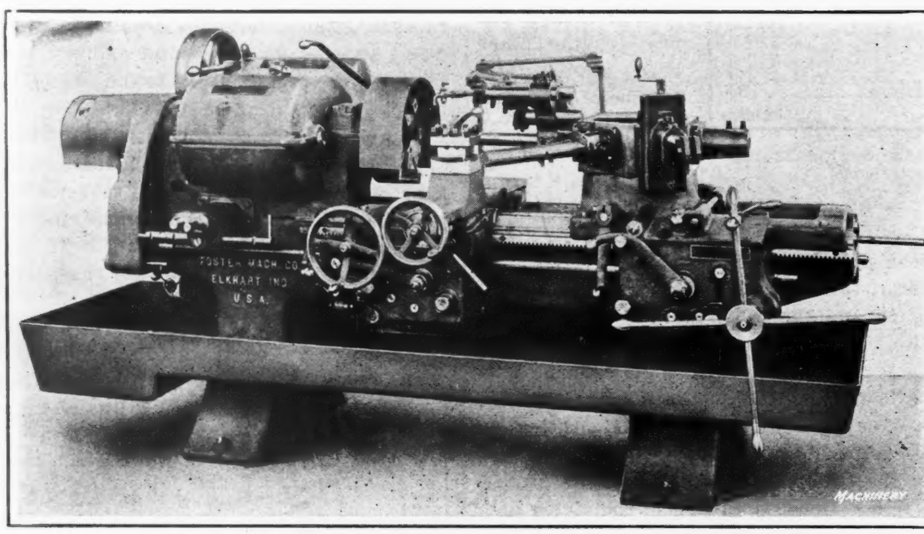


Fig. 1. No. 2B Universal Turret Lathe built by the Foster Machine Co.

Twelve changes of longitudinal carriage feed are available, ranging from 0.0055 to 0.150 inch per spindle revolution, and for the cross-feed there are twelve changes, ranging from 0.0029 to 0.080 inch per spindle revolution. Six of these feed changes and the reverse for them are obtained by means of sliding gears in the apron, and these changes are multiplied by two other adjusting gears in a box located at the head end of the bed to provide either of two speeds of rotation for the feed-rod. A drop-off feed friction in the apron on the turret saddle is automatically disengaged in a manner similar to that operating the feed friction for the carriage apron, control being provided by stops which are adjustably mounted on a long stop-roll located between the ways of the bed. This stop-roll is long enough to take care of work up to the maximum capacity of the machine. The saddle is equipped with quick traverse, which is operated by means of a lever mounted on the front side of the saddle, as shown in Fig. 3. The quick-traverse mechanism is shown in Fig. 2; it is mounted at the rear side of the saddle and consists of a right- and left-hand screw, with nuts which are intermittently locked by means of a double friction controlled by the lever shown at the front of the saddle in Fig. 3. A rod, which is adjustably mounted in a bracket secured to the rear end of the bed, automatically disengages the quick traverse, and thus limits the backward movement of the saddle. The quick-traverse screw is fully protected from chips and dirt by means of a telescoping tube; it is driven from the main driving pulley. Attention is called to the fact that the sliding gear clusters and gears engaging them in the carriage apron are made of chrome-nickel steel, and that the teeth of these gears are of the Fellows stub-tooth standard. The lower gears in the apron run in an oil bath, and all the lower bearings are automatically lubricated.

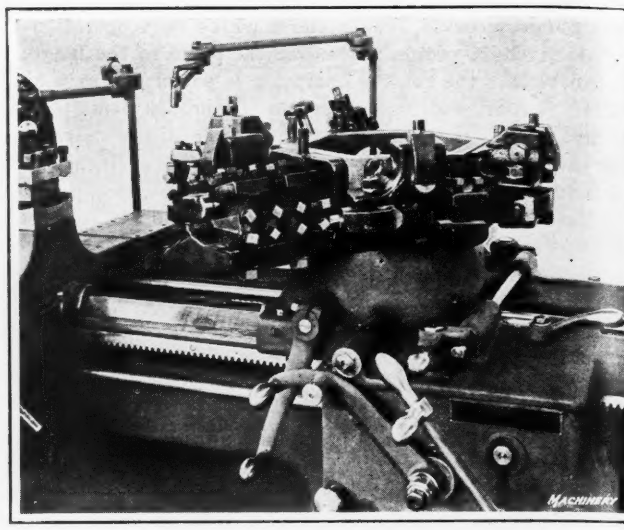


Fig. 3. Close View of Turret, showing Lever that controls Quick-traverse Mechanism

Complete tool equipments for handling both bar and chucking work are designed for use on this machine, and Fig. 1 illustrates a lathe with chucking tools mounted on the hexagon turret. In Fig. 2, the machine is shown equipped for handling bar work. It will be apparent from the illustrations that this machine can be driven by either a countershaft or an individual electric motor, and in cases where electric motor drive is employed, the motor is usually mounted as shown in Fig. 2. The system of supplying

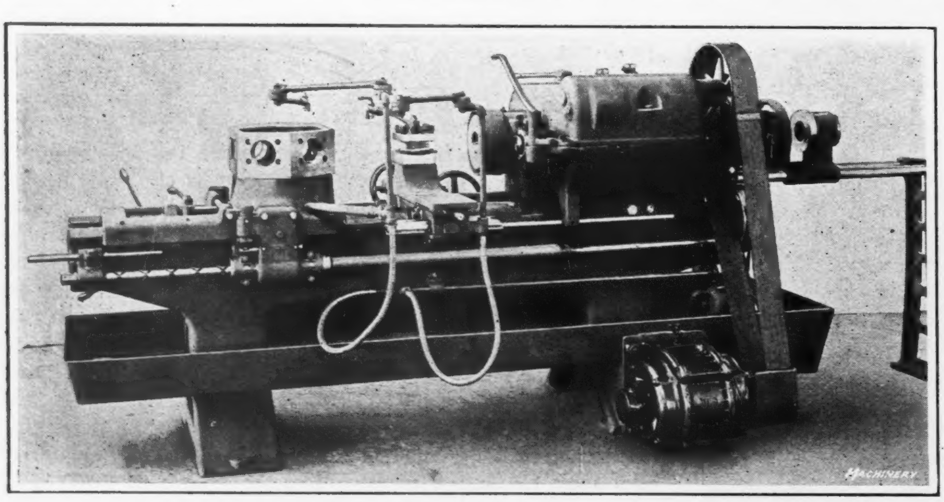


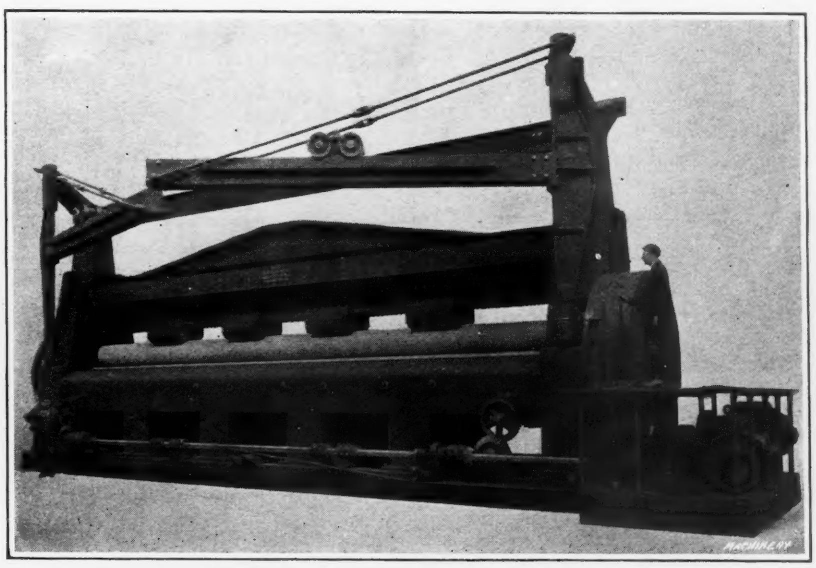
Fig. 2. Rear View of Machine, showing Arrangement of Quick-traverse Mechanism

a copious flow of coolant to the cutting tools has been carefully worked out. Equipped with an automatic chuck and bar feed for standard tools, the machine weighs about 5200 pounds.

NILES-BEMENT-POND HORIZONTAL PLATE-BENDING ROLLS

The accompanying illustration shows a large set of bending rolls recently built at the Niles Works of the Niles-Bement-Pond Co., 111 Broadway, New York City. This machine is of the "strongback" type and has a capacity to roll mild steel plates 1 inch thick by 36 feet long, and 1¼ inch thick by 30 feet long. It consists of two massive cast-iron housings, united at the top by two 20-inch I-beams and below by two heavy cast-iron side frames with bearings for eight pairs of steel rollers, four pairs on each side, to support the lower rolls. The three rolls are made of forged steel, one upper and two lower, each 36 feet 9 inches in length between the journals. The lower rolls are 16 inches in diameter. The rolls are driven by means of a 100-horsepower motor.

The top roll is 19 inches in diameter and reinforced by a heavy built-up steel girder, carrying on the under side four supporting roller bearings directly over those carried on the side frames. This girder and the roll are raised and lowered by means of steel screws, one at each end. The elevating screws are operated by a 75-horsepower motor through a mechanism so arranged that each end of the roll may be raised or lowered independently of the other or both ends together. The whole set of operating handles are grouped together in a convenient point at the motor end, so that the motor controllers and the reversing and clutch levers can be controlled by one operator without moving from his position on the operating platform. The machine is supplied with four top braced jib cranes, self-contained with the machine. The posts for the cranes are at the four corners of the machine.



Horizontal Plate-bending Rolls built at the Niles Works of the Niles-Bement-Pond Co.

BIGGS-WATTERSON THREAD MILLER

For use in milling threads on high-explosive shells and other lines of commercial work, the Biggs-Watterson Co., 1235-1237

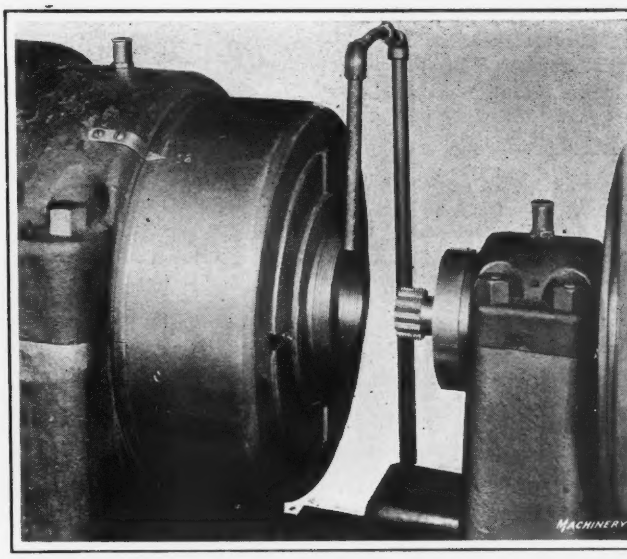


Fig. 3. Close View of Work and Thread Milling Cutter

W. 9th St., Cleveland, Ohio, has recently placed on the market a machine which is shown in the illustrations accompanying the following description. It will be seen that the head and bed are cast integral and, with the oil-pan, are mounted on a pedestal, this design assuring great strength and rigidity. The work-spindle and lead-screw are both rotated from a single worm drive, which assures ample power as well as the required sensitiveness and accuracy. The work-spindle has a hole bored through its entire length, the diameter of which is sufficient to accommodate work of the maximum size that comes within the capacity of the machine, making it possible to introduce work from either end of the spindle as well as to hold pieces of any length. When so desired, the spindle can be equipped with an air chuck; and the work- and cutter-spindles are driven by a single pulley from the countershaft. Right-angle drive or direct motor drive can also be furnished for this machine.

The cutter-spindle is made of high-carbon steel and is carried in a bronze box with provision for efficient lubrication. When so desired, the machine may be equipped with a taper attachment for cutting threads on piping and similar work. A lead-screw provides for moving the carriage longitudinally on the bed, and this screw is engaged by a long nut, which is gripped at any predetermined point by a clamp attached to the carriage. When in a clamped position, the nut moves with the carriage and, when released, it returns automatically to the starting point. This return is effected by two coiled springs, one of which has a right-hand spiral and the other a left-hand

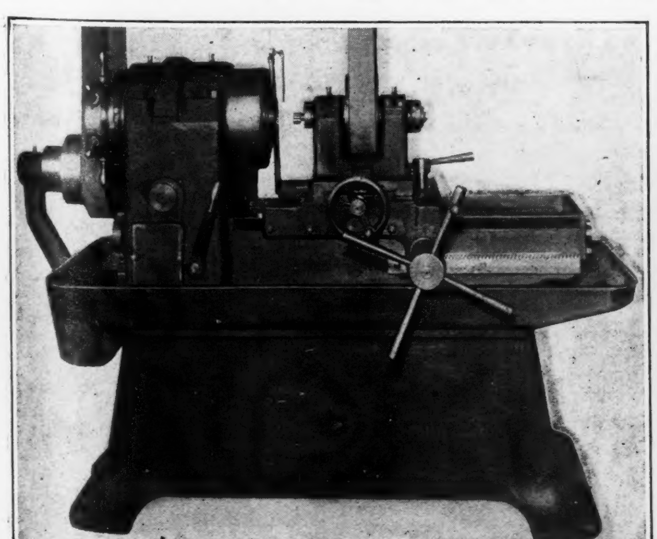


Fig. 1. Machine built by the Biggs-Watterson Co. for milling Threads on Shells and Other Commercial Work

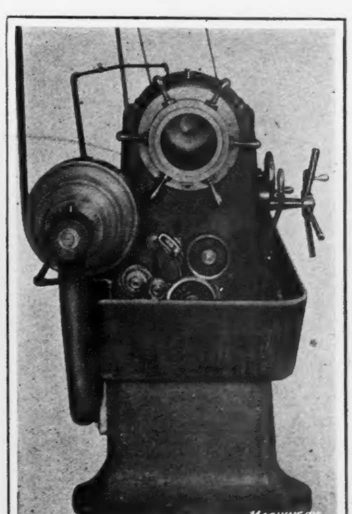


Fig. 2. End View of the Biggs-Watterson Thread Milling Machine

spiral. Provision is made for turning the lead-screw either to the right or to the left, to provide for cutting right- or left-hand threads. The screw is kept under tension at all times, which eliminates backlash. One end of each of the coiled springs is anchored into one end of the cylindrical nut, and at the opposite end, the spring is connected to an adjustable friction. This friction can be set at the proper tension, so that, should the springs be wound too tight, the friction will revolve around the lead-screw and prevent breaking.

A single lever control is provided on the machine, which consists of a camshaft in the front, with a lever at the side of the handwheel directly in front of the operator. This camshaft is connected to the work-spindle, clutch lever, and lead-screw clamp. When the spindle has made one complete revolution, it turns the clamp-shaft over, moves the cutter-spindle back, lifts the cutter out of the work, and disengages the clutch, stops the spindle, releases the clamp, and leaves the carriage free to move on the ways. When a new piece of work is chucked, it is only necessary for the operator to pull over the lever control, which brings the cutter into the work at the right depth, starts the spindle, and clamps the carriage to the lead-screw. The handwheel is only used for making sensitive adjustments of the cutter.

Provision can be made for cutting threads of any pitch, either English or metric, right- or left-hand, by simply changing two gears, no compounding of gears being necessary. An automatic knock-out is provided. At the present time, this machine is being built in 3- and 6-inch sizes. The 3-inch machine has a collet capacity of 3¼ inches; the cutter-spindle is bored No. 9 B. & S. taper; the floor space occupied by the machine is 76 by 36 inches; and the net weight is 3000 pounds. The 6-inch machine has a collet capacity of 6⅛ inches; the cutter-spindle is bored No. 10 B. & S. taper; the floor space occupied by the machine is 76 by 36 inches; and its weight is 3500 pounds.

NEWTON RAIL DRILLING MACHINE

One of the latest additions to the line of machine tools built by the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa., is a multiple-spindle rail drilling machine intended for use in drilling three or four holes which are required in the ends of girders, rails, and similar pieces. All

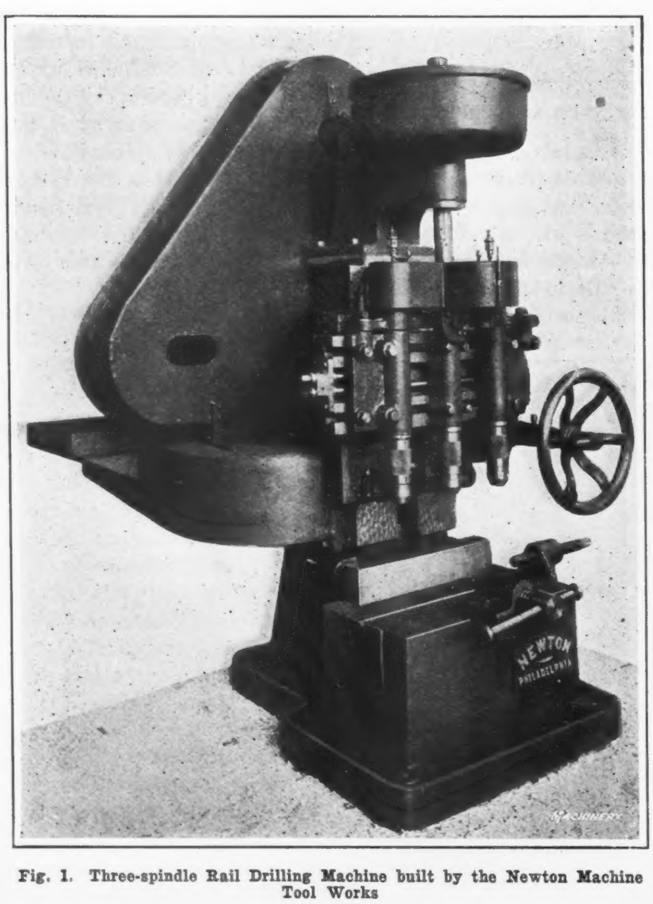


Fig. 1. Three-spindle Rail Drilling Machine built by the Newton Machine Tool Works

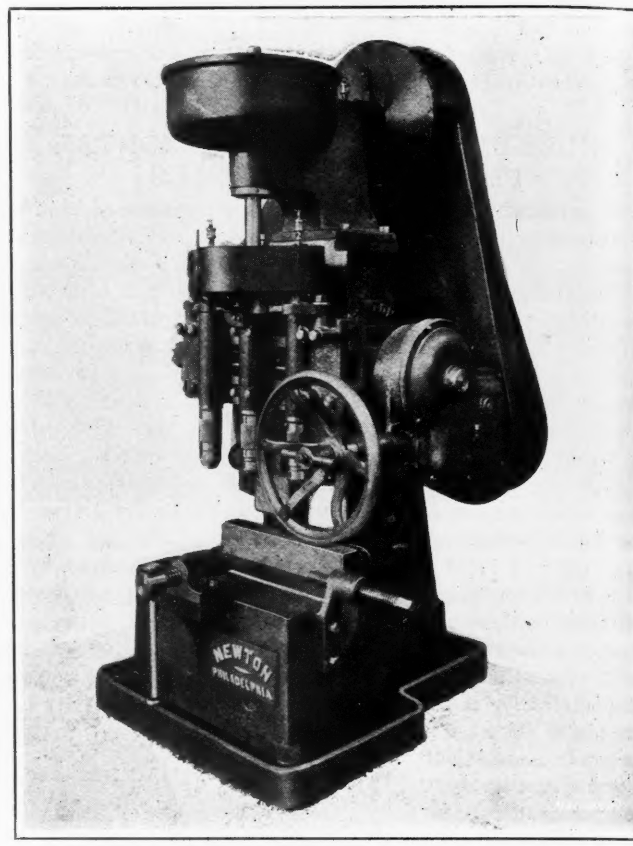


Fig. 2. Opposite Side of Newton Rail Drilling Machine shown in Fig. 1

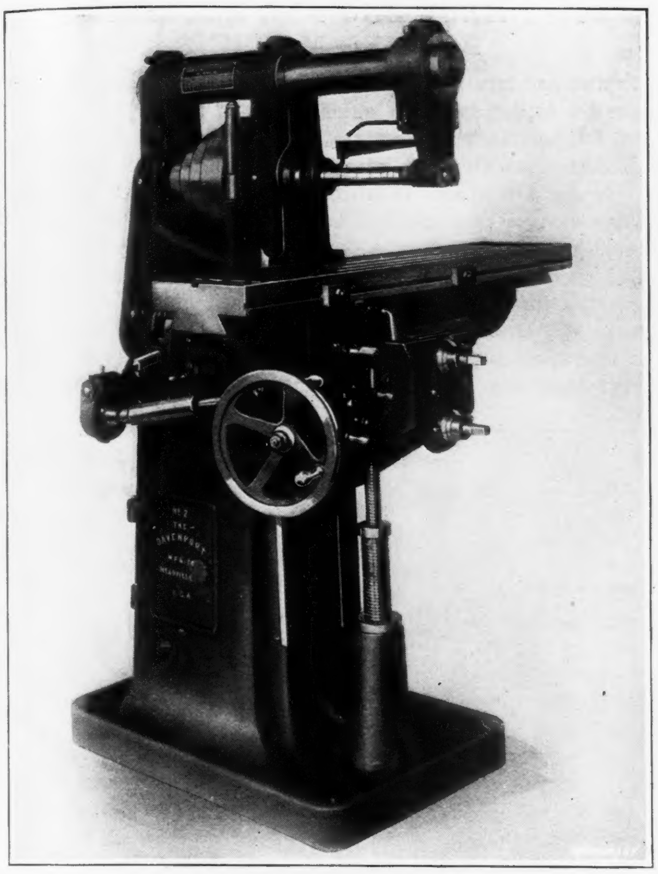
the spindles operate separately, and may be readily removed from the cross-rail when so desired. For drilling the main holes, the spindle speed is 125 revolutions per minute. The work-table is fitted with a slot in the top surface, which is used to assist in holding the rails in position while the drilling operation is being performed. All important bearings in the machine are bronze-bushed, and all the spindles, spindle gears, and rack pinions are made of nickel steel. All gears are enclosed, as is also the motor connecting belt. A pump, piping, and attachments for delivering coolant to the drills are included as part of the regular equipment.

As indicated in the illustrations, the motor is mounted on a bracket at the right-hand side of the machine and connected directly to the main driving pulleys by a belt which is completely enclosed. The drive is then transmitted through bevel and spur gears to the spindles at the top of the machine. Vertical feed and hand adjustment are provided for the saddle, which is counterweighted; there are two changes of feed, the available rates being 0.005 and 0.008 inch per revolution of the spindle. All three spindles are mounted on one saddle and feed in unison, and the machine is shown equipped with chucks for driving rail drills of special design. The base of the machine is surrounded with an oil-pan, and the lubricant tank is located in the base, the piping being arranged to provide for the usual continuous circulation.

The principal dimensions of this machine are as follows: diameter of spindles, 1⅞ inch; minimum distance between spindle centers, 3½ inches; maximum distance between spindle centers, 9 inches (the central spindle is held stationary and the two outside spindles are adjustable by hand-operated screws); maximum distance from top of table to end of spindles, 19½ inches; and size of work-table, 16 to 30 inches.

DAVENPORT NO. 2 MILLING MACHINE

The Davenport Mfg. Co., Meadville, Pa., is now building a No. 2 hand and power feed milling machine, which forms the subject of the following description. On this machine, hand feed to the table is obtained either through a hand-lever, which gives a rapid movement of the table, or through a handwheel, which gives a slower and more sensitive feed. One full movement of the lever moves the table 5 inches, and each revolution of the handwheel effects a movement of 1/4 inch. The hand-lever is made of exceptional length, and may be set at the



No. 2 Hand and Power Feed Milling Machine built by the Davenport Mfg. Co.

point which is most convenient to the operator, or it may be entirely disengaged by a spring plunger. The handwheel is located at any angle with the apron.

Power feed for the table is obtained through a chain-driven feed-box in which six changes of feed are provided. The feed-change mechanism is contained in a single unit, which is assembled complete and placed in the column so that it becomes an integral part of the machine. All feed changes are effected by manipulating two levers, and changes of feed may be made at any time, even while the machine is running under a heavy cut. Reversal of feed is obtained through a push-rod on the feed-box, and all parts of the mechanism are oiled from one large reservoir, which may be easily filled through an opening in the column. When designing the feed-trip, special attention was given to facilitating rapid operation of the machine, and also to making the trips sufficiently sensitive. Automatic trips may be set to disengage the feeds at any point of the table movement and to leave either the hand-lever or the handwheel connected to the table motion.

Oiling of the spindle is accomplished through wicks which are supplied with oil from annular reservoirs cast around the spindle bearings, and glass indicators show the level of oil in these reservoirs at all times. The feed-screws for the transverse and vertical movements are fitted with adjustable graduated dials for gaging the depth of cut, and the elevating screw is made telescopic to overcome the necessity of cutting a hole through the floor. Ball bearings at the top of the elevating screw carry the thrust load and make the vertical movement of the table quite sensitive.

The principal dimensions of this machine are as follows: size of working surface of table, 36 by 9¼ inches; range of table movements, longitudinally, 22 inches, transversely, 6½ inches, and vertically, 19 inches; diameter of over-arm, 3¼ inches; distance from under side of over-arm to center of spindle, 6⅜ inches; size of arbor furnished with machine, 1 inch in diameter by 7½ inches between shoulder and nut; diameter of spindle in front bearing, 2½ inches; taper of spindle, No. 10 B. & S.; diameter of hole through spindle, 11/16 inch; dimensions of cone pulley, 5, 6¾, 8¾, and 10¼ inches in diameter by 2¼ inches face width; range of available spindle speeds, 65, 83, 105, 135, 176, 227, 285, and 367 revolutions per minute, all right-hand; available rates of power feed, 0.003, 0.005, 0.006, 0.008, 0.010, and 0.016 inch per revolution of the cutter; speeds of countershaft, 136 and 175 revolutions per minute; and net weight of machine, approximately 1800 pounds.

ADAMS SHORT-CUT LATHE

A large amount of work done on lathes in most manufacturing plants consists of machining pieces of short length and medium diameter. These are usually placed on the lathes of greater bed length and swing than is required, because the standard sizes made are such, and the power necessary to perform the work is not available on machines of smaller swing. To provide a lathe that will remove these objections, Ogden R. Adams, 159-161 St. Paul St., Rochester, N. Y., is now building a machine which is to be known as the "short-cut lathe." As the name indicates, this machine is a "short-cut" from raw stock to the finished piece, and it can be successfully used not only for roughing cuts equal to the power developed in a standard 16-inch lathe, but also for finishing cuts of extreme accuracy. This machine has a geared head providing six changes of speed through one operating lever and a sliding clutch. The operating lever is placed directly over the headstock where it is convenient for the operator, engaging two friction clutches by a forward or reverse motion, which provides two changes of speed. A sliding positive clutch over the spindle is arranged to give three changes of speed, which in connection with the operating lever makes the six changes always at hand, varying from 23 to 374 revolutions per minute in geometrical progression. All the gears in the headstock run in a bath of oil, insuring perfect lubrication and long life. On the front of the head there is a lock-bolt for holding the spindle from revolving while changing faceplates or chucks.

The spindle is made from a crucible steel forging, turned all over, ground to size, and scraped to a perfect bearing fit. It is bored out to take one-inch bar stock. The front bearing is 2 inches in diameter by 2¾ inches long; and the rear bearing is 1 9/16 inch in diameter by 2 inches long. The bearings are spaced 16½ inches apart; they are tapered with an adjustment for wear that can be taken up on the front of the headstock by one adjusting screw. The nose of the spindle is 2 inches in diameter with six threads, and it is bored to receive a No. 4 Morse taper. The carriage runs on ways usually found on lathes that swing 16 inches and have a bearing of 18 inches. It is gibbed front and back and provided with a locking bolt on the front way for holding the carriage when doing facing or forming work. The cross-slide is 7½ inches wide, and it is furnished with a taper gib to take up wear; it has a microm-

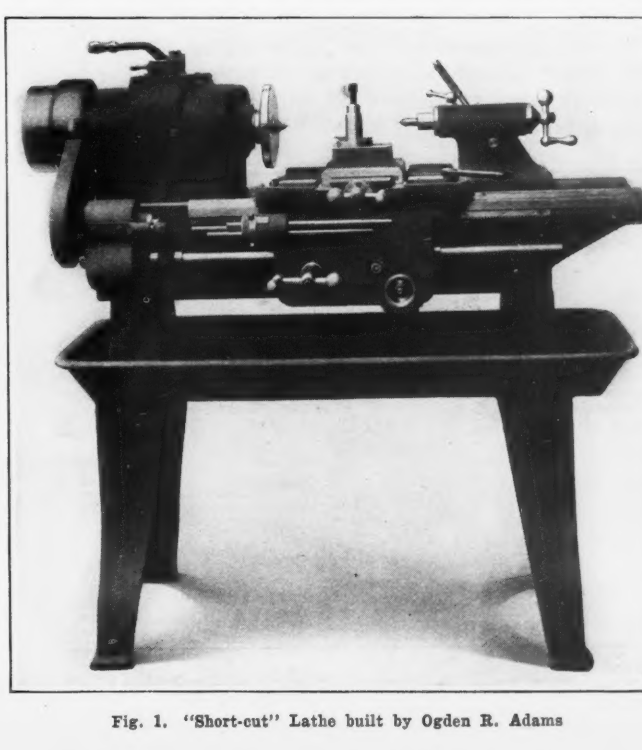


Fig. 1. "Short-cut" Lathe built by Ogden R. Adams

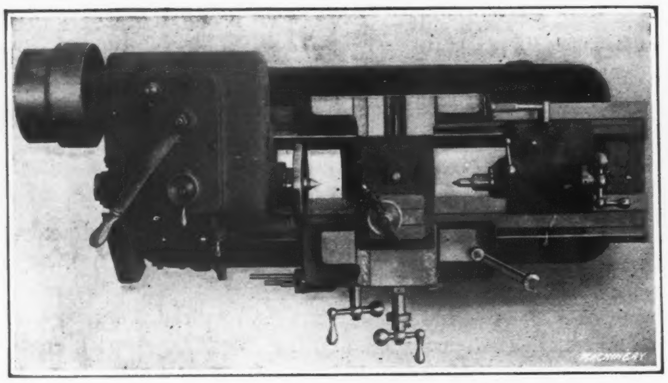


Fig. 2. Top View of the Adams "Short-cut" Lathe

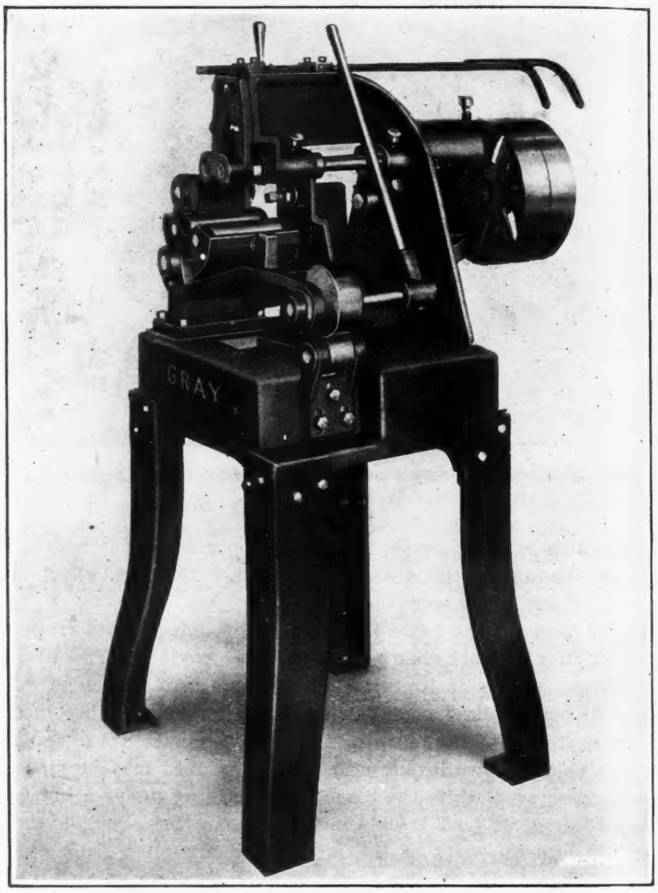
eter collar and carries a tool-block provided for 5/8- by 1½-inch tools. The tail-block is cut away to permit the use of the compound rest parallel with the bed; it is of very heavy design and is arranged to be locked to the bed by the slight movement of a lever and eccentric clamp of great power. The barrel is 1½ inch in diameter and 8½ inches long.

The feeds are positive and may be obtained instantly. They are three in number and vary from 0.007 to 0.020 inch per revolution of the spindle. Three more changes may be obtained by interchanging two slip gears and thereby doubling these feeds. The carriage will stop at any predetermined point by three stop-bars set on a rod, operated by a positive throw-out clutch, and a safety device is provided in the feed mechanism to prevent injury or breaking of the gears. Shoulder stops for various lengths make possible the production of duplicate parts. This lathe is always supplied with an oil-pan and short legs. One of the legs is made hollow and serves as a reservoir for holding cutting compound. This feature is only supplied on order. The lathe swings 12¼ inches over the ways and takes 19½ inches between centers. It weighs about 1200 pounds. It is regularly built with a plain rest, but can be supplied with a compound rest, heavy-duty back-forming rest, taper attachment, draw-in chuck and collets, thread-chasing device, and a two-speed countershaft.

The principal dimensions of this lathe are as follows: swing over bed, 12¼ inches; capacity between centers, 19½ inches; length of bed, 48 inches; width of belt, 2 inches; diameter of hole through spindle, 1⅛ inch; maximum capacity of wire chuck, 3/4 inch; size of front bearing, 2¾ inches diameter by 2 inches long; rear bearing, 1 9/16 inch diameter by 2 inches long; available rates of feed, 0.007, 0.015, and 0.020 inch per revolution of the spindle without changing gear; length of carriage, 18½ inches; width of cross-slide, 7¼ inches; range of spindle speeds running pulley at 200 revolutions per minute, 23 to 374 revolutions per minute; size of tools used, 5/8 by 1½ inch; size of tailstock spindle, 1½ inch diameter by 7 inches long; length of machine, 48 inches; height to center of spindle, 42 inches; height to the top of machine, 48 inches; and width of machine, 30 inches.

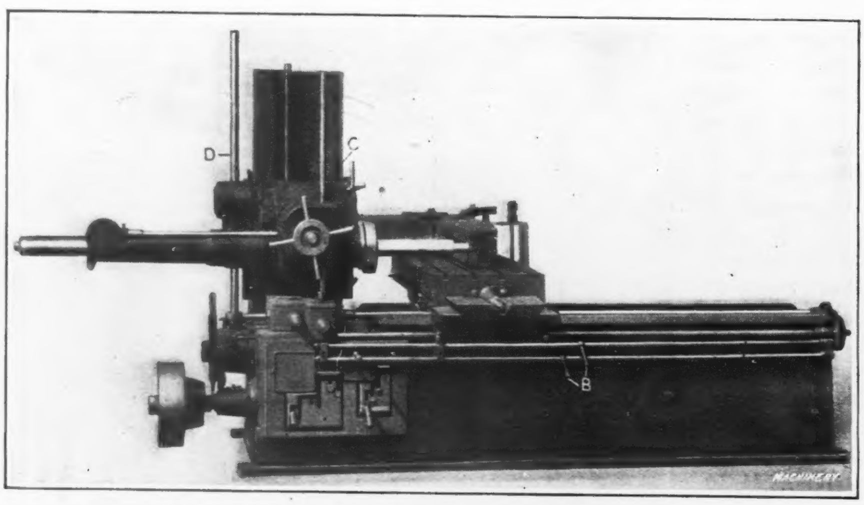
GRAY KNURLING AND BOURRELET ROLLING MACHINE

In the accompanying illustration is shown a knurling and bourrelet rolling machine which is one of the recent products of the Gray Machine Tool Co., Inc., 2661 Main St., Buffalo, N. Y. This machine is intended for knurling the copper band groove on 3-inch and 75-millimeter shells, and it is shown equipped with two spindles and two knurls to provide for double- or cross-knurling, although the machine is ordinarily built with one heavy spindle for a single knurling tool. In operating this machine, a shell is placed on the two lower rollers with the base pushed up against a stop, after which the operation is completed by simply pulling a lever. It is stated that this machine will knurl shells as fast as they



Knurling and Bourrelet Rolling Machine built by the Gray Machine Tool Co.

can be fed to it. For use in rolling the bourrelet, the rolling tool is placed on the spindle in place of the knurl, and a different set of rollers is used for supporting the shell. All tools and rollers used on this machine are made of cast steel and hardened. Power is transmitted to the machine from a line-shaft through a pair of tight and loose pulleys which are 12 inches in diameter by 3 inches face width, and run at 325 revolutions per minute. The machine weighs approximately 700 pounds.



Horizontal Boring Machine recently placed on the Market by the Lambert Machine & Engineering Co.

LAMBERT HORIZONTAL BORING MACHINE

The Lambert Machine & Engineering Co., 1967 E. 55th St., Cleveland, Ohio, is now building a horizontal boring machine. On this machine, all bearings are provided with either ball bearings or bronze bushings, and all gearing is made of steel. The operation is facilitated by the provision of a start and stop mechanism for the feed movement and for the revolution of the boring-bar. It will be seen that two horizontal bars *A* run along the front of the bed on which two

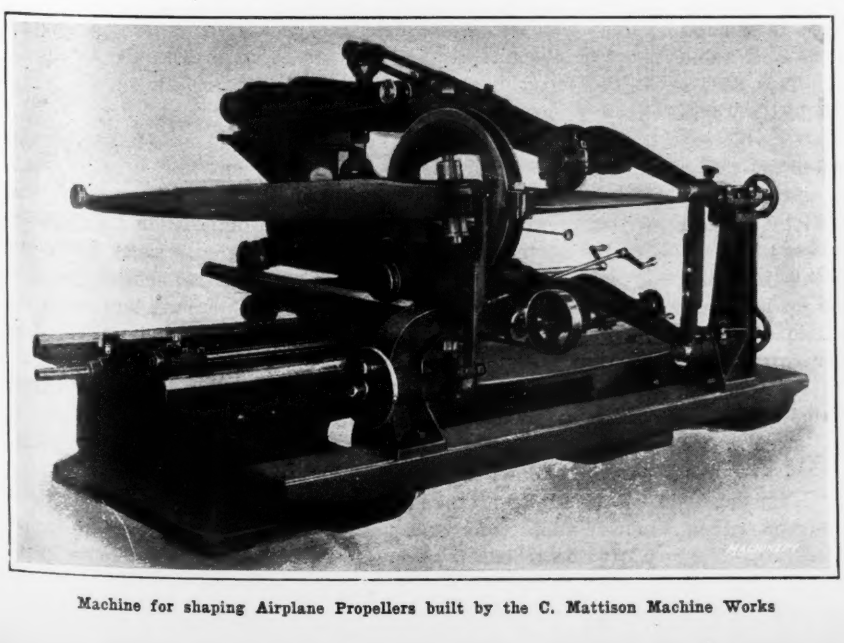
short levers *B* are mounted. One of these levers provides for starting, stopping, or reversing the feed movement, and the other provides for starting, stopping, or reversing the revolution of the boring-bar. These handles may be slid to any convenient position on the horizontal bars so that they are within easy reach of the operator. A patent has been applied for on this mechanism.

A vernier *C* is provided for making accurate vertical settings of the saddle and boring-bar; and shaft *D*, which transmits power to the saddle, is stationary so far as vertical movement is concerned. By having this shaft mounted in a fixed position instead of sliding up and down, no trouble is experienced through the necessity of having to cut a hole through the floor to accommodate the end of this shaft, when in its lower position. Gear guards are provided over the gears that are shown exposed at the end of the bed.

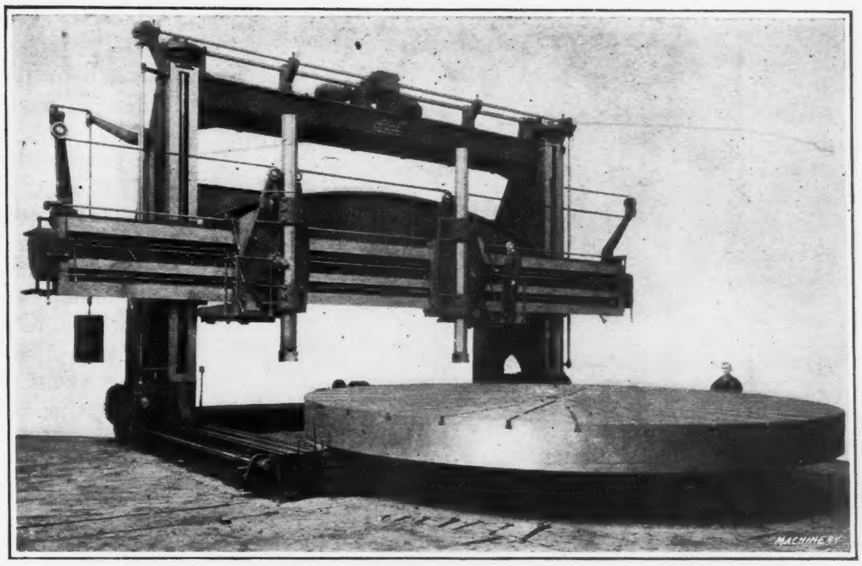
The principal dimensions of this boring machine are as follows: diameter of bar, 3 inches; taper hole in bar, No. 5 Morse; maximum longitudinal travel of bar, 24 inches; maximum distance from center of spindle to top of table, 30 inches; minimum distance from center of spindle to top of table, 1/2 inch; size of table, 20 by 48 inches; maximum cross-feed of table, 38 inches; maximum distance from faceplate to outer support, 72 inches; size of driving pulley, 14 inches in diameter by 4 inches face width; speed of driving pulley, 240 revolutions per minute; number of available spindle speeds, 12; number of available rates of feed in either direction, 16; range of feeds per revolution of the boring-bar, 0.005 to 11/32 inch; vertical travel of head (with vernier reading), 22 inches; vertical travel of head (with dial reading), 30 inches; and longitudinal power travel of table, 52 inches.

MATTISON PROPELLER SHAPING MACHINE

For use in forming airplane propellers, the C. Mattison Machine Works, Beloit, Wis., are now building a special shaping machine which forms the subject of the following description. This machine employs the pantoscope principle of copying, the propeller being held stationary while the cutter is reciprocated back and forth over it, shaping one side of the work at a time. It is claimed that this results in greater accuracy than can be accomplished where the propeller is revolved as on a copying lathe. Capacity is provided for shaping propellers up to 12 feet in length, and blades may be shaped up to 15 inches in width. This machine is adapted for making three- and four-bladed propellers, as well as propellers of the two-bladed type. A universal chuck is employed for clamping the hub of the propeller blade, and a special cutter-head has been developed which cuts with a shearing action.



Machine for shaping Airplane Propellers built by the C. Mattison Machine Works



Niles-Bement-Pond Extension Boring and Turning Mill with Housings back, giving 42-foot Swing

NILES-BEMENT-POND EXTENSION BORING AND TURNING MILL

In the accompanying illustration is shown an extension boring and turning mill recently built by the Niles-Bement-Pond Co., 111 Broadway, New York City, for arsenal work. This machine swings 28 feet 2 inches with the housings forward and 42 feet 4 inches with the housings back. The maximum height under the tool-holders is 10 feet and the bar travel is 84 inches. The table is driven by a 60-horsepower motor through a double pinion drive; a 25-horsepower motor is used for elevating the cross-rail and a 15-horsepower motor for fast traversing the bars and saddles. A separate 15-horsepower motor is used for traversing the housings. The cross-rail has two heads with octagon bars 10 inches across the flats. The cross-rail is 48 inches in width and 54 inches in depth from front to back. The table is designed to safely carry a load of 300,000 pounds in addition to its own weight. It is driven by two forged steel pinions, one located on each side of the table. The heads on the cross-rail are provided with platforms for the operator. Adjustment of the feeds and rapid traverse for the bars and saddles is controlled from the platforms. The main driving motor is also controlled from these platforms as well as from stations at each side of the machine. Push-button control is provided for all motors.

UNIVERSAL TAPPING MACHINE

F. Lowenstein, 397 Bridge St., Brooklyn, N. Y., is now manufacturing what is known as a "universal" tapping machine, because it is so constructed that adjustment may be made for using the spindle in a horizontal or vertical position or set at any angle which may be most convenient to meet the peculiar requirements of the work. This machine consists of three essential parts, namely, a base, swivel head, and frame which carries the spindle. It will be seen that the swivel head is provided with a circular slot to receive the clamping bolt which provides for securing the frame and spindle in any desired position. In Fig. 1 the machine is shown set up for operation horizontally, and Fig. 2 shows the same machine with the spindle swung through an angle of 90 degrees to bring it into a vertical position. It would be entirely practicable to operate the machine with the spindle in any intermediate position, or the spindle could be swung on to any desired position until it stood horizontal with the tap pointing in the opposite direction to that shown in Fig. 1.

The machine is shown equipped for belt drive from a countershaft, but where it is desired to use individual electric motor drive, a motor is bolted to the back of the base. The

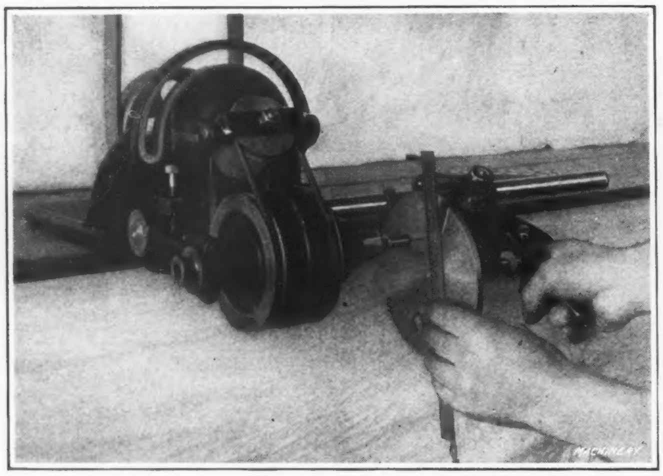


Fig. 1. Lowenstein Universal Tapping Machine with Spindle in Horizontal Position

illustrations make apparent the way in which a round belt runs over a pulley at the front of the driving shaft, thence over one pulley on the tapping spindle, and then around the idler pulley on the swivel head and back over the second pulley on the tapping spindle to the pulley on the driving shaft. In this way, the two pulleys on the spindle are running in opposite directions, which provides means of reversing the tap so as to back it out of the hole. In order to tighten the round driving belt, the spindle frame is hinged to the swivel head, and by means of a screw adjustment, the belt tension can be modified to any degree required for obtaining proper running conditions of the machine. Placed between the two pulleys on the spindle, there is a friction clutch consisting of a disk covered with leather pads. When the work is fed up to the tap, it causes the clutch to engage the "forward" pulley to drive the tap into the work; then, when the work is drawn away from the tap, the clutch is pulled over into engagement with the "reverse" pulley, which backs the tap out of the hole.

The spindle on this machine occupies a fixed position as regards longitudinal movement, and feeding is accomplished by moving the work up to the tap. When the machine is used with the spindle in a horizontal position, this feed movement is accomplished by a hand-lever, and with the spindle in a vertical position, feeding may be done either with the hand-lever or with a treadle connected to the chain shown in Fig. 2. This chain is adjustable in length to suit the location of the table and is connected to an extension back of the hand-feed lever. This lever is pivoted and connected with a yoke secured to the rod on which the work-table is carried. This rod is a sliding fit in its brackets, so that movement of the feed-lever causes the table and work to be advanced to the tap or withdrawn. The capacity of this machine is for tapping holes up to 1/4 inch in diameter in brass or soft alloys, and holes up to 3/16 inch in diameter can be tapped in steel. The forward and reverse clutches are engaged by the feed movement of the spindle.

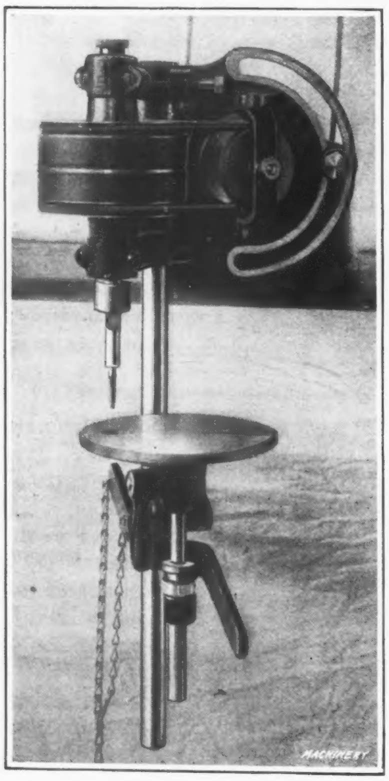
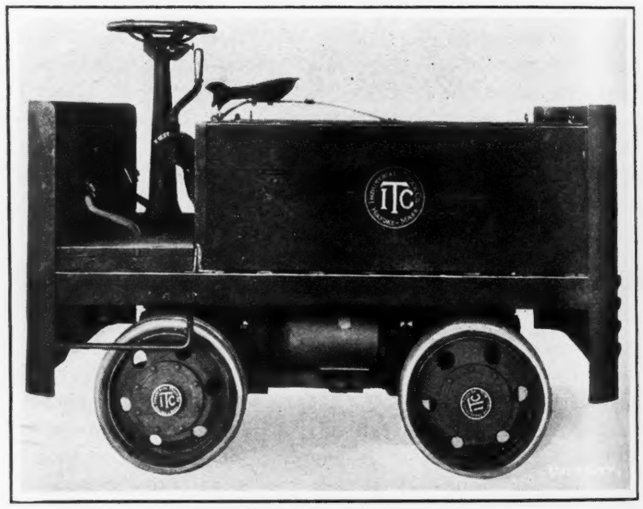


Fig. 2. Lowenstein Tapping Machine with Spindle set Vertical

INDUSTRIAL TRACTOR AND LOCOMOTIVE

The Industrial Truck Co., Holyoke, Mass., is now manufacturing four types of load-carrying trucks and two types of industrial tractors, one of which is equipped with end control and the other with central control, that is, machines where the operator sits at the center of the tractor and can, by changing his seat, operate in either direction without having to turn the tractor around. In driving a tractor through a narrow, congested aisle, this is often a very convenient feature. Both types of tractors steer on all four wheels and are built with either two- or four-wheel drive. The frame is built of commercial rolled channel-section steel, and the bumper plates are constructed of boiler plate bent on the corners and riveted to the frame. By making the coupler castings of the three-step type, accommodation is provided for different heights of trailers. The battery boxes are constructed with easily removable side doors for changing batteries, and hinged top plates to afford easy access for flushing or inspection. Any type of battery can be supplied up to a maximum of forty-two cells of the A8 Edison, or twenty-four cells of the 21 lead-plate type. The frame with the battery box can be lifted from the chassis by simply removing four nuts, leaving the entire driving mechanism accessible for inspection or the making of repairs.

Power is transmitted from the motor through a single reduction worm and gear down through the differential to the wheels, by means of a universal joint which is capable of



Storage Battery Electric Tractor built by the Industrial Truck Co.

operating at an angle of 43 degrees. This universal joint is enclosed in a dust- and oil-tight case, formed by the pivoting wheel knuckle and its supporting yoke. Ball bearings are provided in the wheels, and pivot bearings of a suitable size are provided, which makes the tractor easy to steer. Two separate brakes are furnished, one of which is operated by the left foot, which is an emergency brake, and one by the right foot, which is the regular service brake. The design of this tractor has been made as nearly fool-proof as possible. In order to operate it, the driver must be sitting in his seat with his left foot pressing the emergency brake pedal. Every time his foot is lifted from the pedal, the brake is applied, bringing the machine to a stop, and by means of a clutch on the controller shaft, throwing the controller handle out of gear and the controller to the neutral position. It is then impossible to start the tractor again without first releasing the emergency brake and bringing the controller handle back to the neutral position. The electric horn signal is operated by a push-button on the controller handle. An additional safety device is provided by locating the tilting steering wheel in such a way that the operator must move it before leaving his seat. This tilting wheel is interlocked with the controller shaft clutch, so that under no circumstances can the battery current be supplied until the wheel is back in the running position.

The Industrial Truck Co. is also building an industrial locomotive adapted for any practical gage of track from 24 inches up to the standard gage of 56½ inches. Flanged wheels are

substituted for rubber-tired wheels used on the tractor, but, aside from this difference and the fact that the differential, universal joint driving mechanism, and steering mechanism have been dispensed with, it is of essentially the same design as the tractor.

LANGELIER AUTOMATIC IGNITION TUBE DRILLING MACHINE

The machine shown in Figs. 1 and 2 was designed especially for drilling simultaneously and automatically the twenty-two holes in the ignition tube, Fig. 3. The machine produces an output of 20 tubes per minute or 12,000 for a day of ten hours. The equivalent in holes is 264,000. The tubes are made from drawn brass tubing 0.538 inch outside diameter, with a wall thickness of 0.035 inch, and are 4.158 inches in length. The size of the hole is 0.141 inch. Each tube has twenty-two holes. The only duty required of the operator is to keep the vertical magazine slide filled with tubes. All the other functions in the machine are performed automatically. The tubes are pushed one at a time from the bottom of the magazine into a jig in which are located the drill guide bushings. The jig has also an inner spring sleeve which squeezes the tube and holds

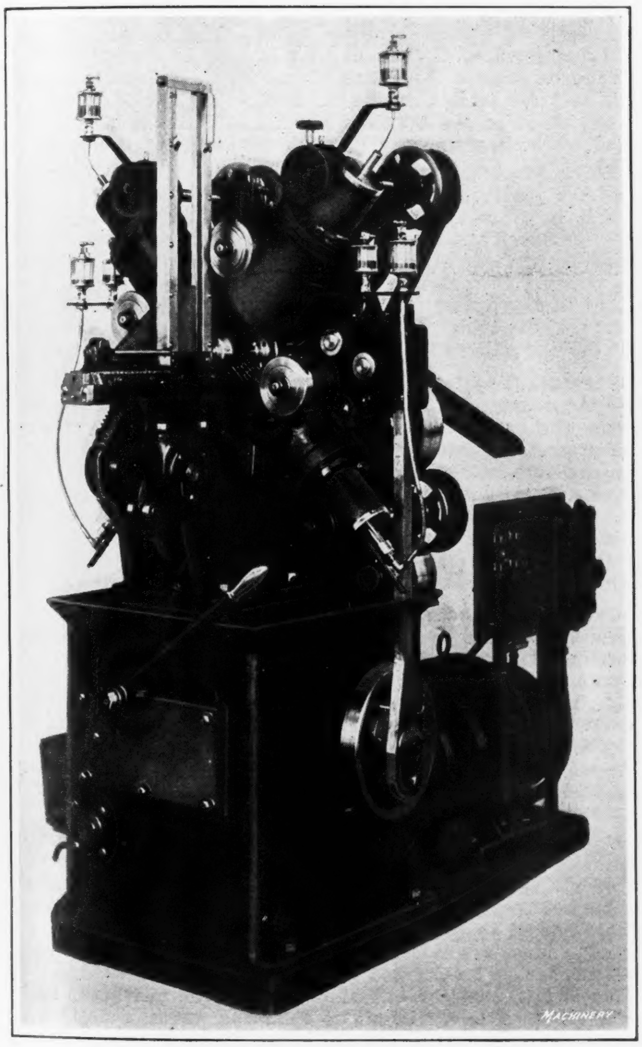


Fig. 1. Langelier Automatic Ignition Tube Drilling Machine

it firmly while being drilled. The tubes are pushed one ahead of the other to the rear of the machine where they fall into a chute which leads into a receiving box at the side of the machine. The jig is provided with a chamber into which is led compressed air and a stream of oil which thoroughly lubricates the drills and also keeps the inside of the jig absolutely free from chips.

The tubes are fed into the drilling jig by a reciprocating plunger mounted in a dovetail slide, a segment gear and cam-bar, by a camshaft in the back of the machine. The cam-bar is provided with a collapsing arrangement so as to avoid breakage in case a tube should get jammed in any way, the possi-

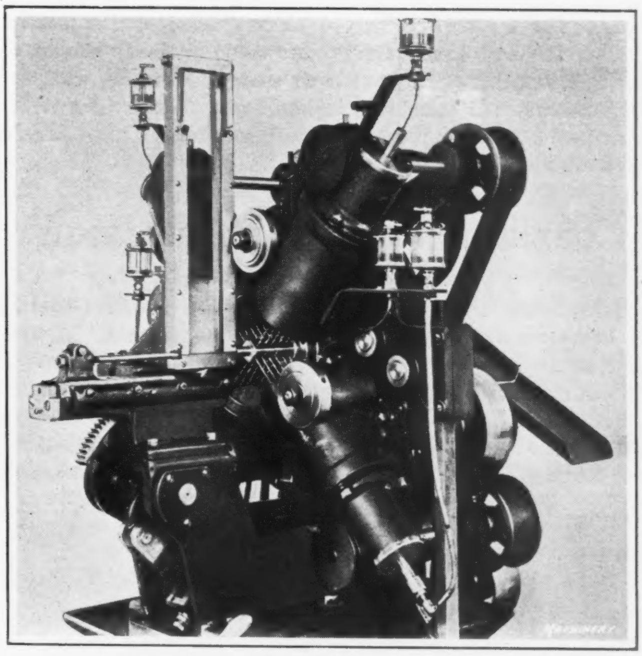


Fig. 2. Close View of Upper Part of Machine shown in Fig. 1

bility of which is very remote. The magazine slide is held in position by two quick removable belts, so that it can be quickly taken off, so as to facilitate the taking out and putting in of the drills when they are sharpened. The machine has four multiple drilling heads mounted radially, 90 degrees apart upon a faceplate that is trunnioned and fastened to the frame of the machine. Two of the heads that are diametrically opposite to each other have six spindles each and the other two, five spindles each. Each multiple drill head is mounted in a feed sleeve that is actuated through a double pinion by a ring gear located concentrically inside of the faceplate. The ring gear is connected by intermediate compound gears to a cam-bar that is operated by the camshaft in the base of the machine.

Each feed sleeve is provided with a cut-out that permits the drill heads to be adjusted individually to their proper drilling positions. The drilling head main spindles are mounted on ball bearings and are driven by spiral gears completely enclosed and running in oil. The spiral gear driving shafts are also mounted on ball bearings. They extend to the rear of the machine and are driven by an endless belt passing over the pulleys on their ends. Intermediate idler pulleys are used to obtain belt contact and the upper idler pulley is mounted with a screw adjustment so that the proper belt driving tension can be maintained. All idler pulleys are mounted on ball bearings. The endless belt combination of pulleys is driven by gears in couples by a belt from the motor.

The feeding mechanism of the machine is controlled by two face cams, one on the outside of the base for feeding the drill heads and the other on the inside for operating the feed plunger. The camshaft is driven by a worm and gear and the worm is geared in its proper ratio to the motor shaft. The camshaft is provided with a clutch that is operated by the hand-lever at the front of the base, so that the feeding mechanism can be stopped at any time by the operator. Sight-feed oilers with gravity feed are provided so as to insure a generous lubrication to the multiple drilling heads. The drilling spindles have a speed of 2800 revolutions per minute. An automatic oil-feed pump with filtering arrangement is belted to the motor shaft for supplying the cutting oil. The entire machine including the motor and appliances rests upon a heavy floor-

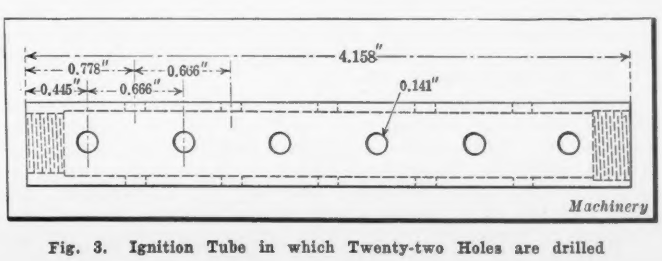
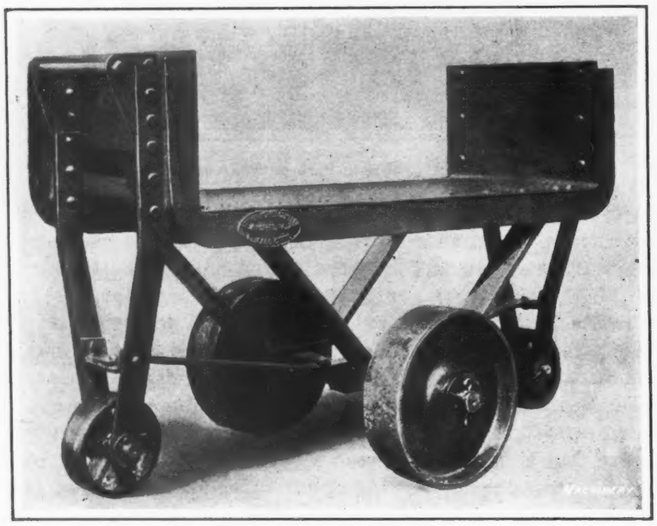


Fig. 3. Ignition Tube in which Twenty-two Holes are drilled

base. The machine is driven by a five-horsepower semi-enclosed, 110-volt, direct-current shunt-wound Westinghouse motor. The machine occupies a floor space of 30 inches wide by 60 inches long, and stands 68 inches high. The weight is 3500 pounds. This machine is a recent product of the Langelier Mfg. Co., Arlington, Cranston, R. I.

ORENSTEIN-ARTHUR KOPPEL HIGH-LEVEL TRUCK

Much time is lost and the efficiency of a machine operator is considerably reduced if he is required to stoop in transferring material from a truck to his machine, and vice versa. It was to eliminate this source of lost time that the high-level truck shown in the accompanying illustration was designed. This truck is so constructed that the whole load is balanced on the center axle, which is provided with large-diameter,



"High-level" Industrial Truck manufactured by the Orenstein-Arthur Koppel Co.

wide-tire wheels, supported on roller bearings, which make the operation of the truck so easy that, although it is heavily constructed and has a rated capacity of two-thirds ton, the truck can be easily moved around when fully loaded. This truck is one of the recent products of the Orenstein-Arthur Koppel Co., Koppel, Pa.

NEW MACHINERY AND TOOLS NOTES

Toolpost Grinding Attachment: Gale-Sawyer Co., 33-37 Wormwood St., Boston, Mass. A toolpost grinding attachment furnished with a swiveling device which is graduated to provide for making accurate adjustments. This is said to be especially useful when sharpening cutters with end teeth and performing similar operations. Provision is made for driving the spindle at from 8000 to 12,000 revolutions per minute.

Bench Furnace: Johnson Gas Appliance Co., Cedar Rapids, Iowa. A No. 118 bench furnace which is suitable for use in machine shops and tool-rooms. Gas is used for fuel and it is claimed that temperatures from 1400 to 1800 degrees F. may be obtained without the use of a forced air blast. A removable melting pot may be placed on top of the furnace, and the opening into which this pot fits is filled by a cover plate when the pot is not required.

Motor-driven Trucks: Baker R. & L. Co., Cleveland, Ohio. A line of industrial trucks and tractors driven by storage batteries and electric motors, in which all parts have been carefully standardized. The work of standardization has been carried to a point where the different parts can be used on trucks of all models. Two- and four-wheel drive, four-wheel steer trucks, tractors, and elevating platform trucks are included in this line of industrial trucks.

Folding Blueprint Rack: National Co., 273-279 Congress St., Boston, Mass. A folding wall rack adapted for holding blueprints and other sheets of similar form. This rack is furnished with the "Presto" blueprint holder of this company's manufacture, which has been described in MACHINERY. The rack consists of a frame which hangs against the wall and supports a horizontal rack which projects out from the wall and carries the "Presto" blueprint holders.

Castellating Machine: Matthews Engineering Co., Sandusky, Ohio. (The machine is sold by the J. R. Stone Co., Detroit, Mich.) A machine especially designed for use in castellating nuts or other small parts which are suitable for chucking. The work is placed in a hopper and fed through a chute to the chucks. As each piece is chucked, it is carried around under the milling saws which feed downward and are then lifted automatically while the chuck table is indexed.

Shell-turning Attachment: Amalgamated Machinery Corporation, 72 W. Adams St., Chicago, Ill. An attachment devised by D. M. Derrom, works manager of the Winslow Bros. Co.'s shell plant in Chicago, to avoid trouble sometimes experienced through a constant change of the angle that the cutting edge of the tool presents to the work as it moves over the contour of the shell. Attachments of this kind are regularly furnished on Amalgamated lathes intended for use in shell turning.

Bench Grinding Machine: Temco Electric Motor Co., Leipsic, Ohio. A portable bench grinding machine provided with two emery wheels driven by an electric motor which is furnished with a cord for making connection with an ordinary lighting socket. The electric motor develops one-sixth horsepower, and the wheels which are 6 inches in diameter by 1/2-inch face width run at 3700 to 3800 revolutions per minute, depending upon whether connection is made with an alternating- or direct-current circuit.

Multiple-spindle Drilling Machine: Langelier Mfg. Co., Arlington, Cranston, R. I. A machine especially designed for use in drilling twenty-four holes 0.031 inch in diameter in the walls of primer ignition tubes. The machine is hand- and foot-operated and the drilling is done by six-spindle multiple heads located 90 degrees apart on a vertical faceplate. The spindles in one head are offset to a position midway between those in the opposite head, and drills carried by each head work diametrically through the walls of the tube.

Filing Machine: Advance Engineering Co., 848 Massachusetts Ave., Indianapolis, Ind. A bench type of die filing machine which is of compact construction, with moving parts carefully balanced and completely enclosed. All bearings and other wearing surfaces are made of bronze, and may be replaced if necessary. Provision is made for tilting the table to angles up to 10 degrees on either side of the central or vertical position, and the table may be turned around on the base to locate the driving pulleys at either side or at the rear of the machine.

Pressure Toggle: R. D. King, Monadnock Block, Chicago, Ill. A pressure toggle for use on presses to provide for regulating the pressure exerted on the work during the stroke of the press. Provision is made for adjusting the device so that the pressure will remain uniform during the entire stroke or so that it will either increase or decrease toward the latter end of the stroke. This pressure toggle is attached to the bolster plate with two rods and remains stationary while the plate supporting the drawing pins is moved up or down for adjustment by means of a handwheel.

Galvanizing Machine: E. L. Watrous, Des Moines, Iowa. A machine invented by Mr. Watrous and installed in the plant of the Hanlon-Gregory Galvanizing Co., Pittsburg, Pa. This apparatus is designed to handle small products such as nuts, bolts, nails, wood-screws, and similar articles. It is of simple design and the work to be galvanized is placed in a wire basket, from 50 to 100 pounds of work being treated at a time. The work is dipped into a kettle, and when sufficiently treated the basket is lifted out and transferred to the machine where excess zinc is removed by a centrifugal action.

Non-ferrous Melting Furnace: U. S. Smelting Furnace Co., Belleville, Ill. A melting furnace for non-ferrous metals, which is of the revolving tilting type. Either fuel oil or gas may be burned to produce the heat required for melting the metal. The material to be melted is put through the charging hole, and the burner which swings to one side in order to permit the furnace to be charged is then adjusted and lighted. The flame is projected through the center of the melting chamber, although it does not impinge upon the metal, reflected heat from the lining of the furnace being relied upon to bring the charge to the melting point.

Turret Toolpost: Craig & Coffman, 3714 Flora Ave., Kansas City, Mo. A turret toolpost which is made in two standard sizes, although larger sizes can be made to special order. On the larger sized standard equipment, the turret is 3½ inches square and carries three 3/8-inch square cutters and one 3/4-inch standard cutting-off plate. On the smaller size, which is adapted for use on bench lathes, the turret is 2½ inches square and carries three 1/4-inch square cutters and one 1/2-inch cutting-off plate. These turret toolposts provide a convenient method of using roughing, finishing, threading, and cutting-off tools in rapid sequence for the production of duplicate parts.

Circuit-breaker: Roller Smith Co., 233 Broadway, New York City. A line of self-timing circuit-breakers which are so designed that they always tend to trip instantaneously with the load for which adjustment has been made. Interposed in the path of its trip armature there is a pivoted, hook-shaped

barrier, which is under two independent controls. One of these is thermal, so that expansion of a metal rod heated at the same rate the motor is heated by the passage of current retracts the barrier and allows the breaker armature to trip in case of excessive heating. The other control is electromagnetic and instantaneously retracts the barrier and allows the trip to operate in case a heavy overload occurs.

Tool-holder: Green Bay Drive Calk Co., Green Bay, Wis. A line of tool-holders which are made in five different sizes, of either straight, right-hand offset, or left-hand offset type. These tool-holders are furnished with a center piece, which is pivoted and provided with a tongue at one end and a set-screw at the opposite end. A tool steel bit of sufficient length is held by a double grip, but short pieces of steel are held under the tongue on the pivoted section and secured by pressure applied by tightening the set-screw against the body of the holder. Tool-holders of this type are made in sizes ranging from 1/2 by 1 1/8 by 6 up to 1 by 2 by 11, and have capacity for holding square tool steel bits from 5/16 to 5/8 inch square.

Enclosed Electric Traveling Crane: Shepard Electric Crane & Hoist Co., Montour Falls, New York. A crane built for use in the Cuyahoga Works of the American Steel & Wire Co., in Cleveland, Ohio. The feature of especial interest in the design of this crane is that all parts of the mechanism have been completely enclosed in order to afford protection against damage from dust and other foreign matter which finds its way into the armatures, bearings, and other members. Where no protection is afforded, some plants find it necessary to clean the motors and other parts of their cranes as often as once or twice a week with compressed air, but this trouble has been completely overcome by the enclosed form of construction provided on the Shepard crane. It has a span of 76 feet 8 inches and a capacity for carrying ten tons. It is adapted for use in connection with electromagnets for lifting the load.

Electric Light Holder: Light Holder Mfg. Co., 79 E. 130th St., New York City. An adjustable electric light bracket which is known as the "New York Universal." This device makes it an easy matter to hold a light in the best position to enable a mechanic at the bench or machine to obtain a clear view of his work. Holders of this type are made in several styles which are designed to be supported from the floor, bench, overhead works of a machine tool, or in other convenient ways. Adjustment for length is provided by means of telescoping members of the bracket, and swivel joints provide movement in any direction. A lamp socket of ordinary form snaps into a spring yoke and no screws are required to hold it in place. All joints and movements of the bracket are held by friction under the tension of adjustable springs, so that to move the light from one position to another requires scarcely more than a movement of one hand, as the fixture moves easily and the light stays in whatever position it is placed.

* * *

A course of training for employment managers under the supervision of the Government has been opened at the University of Rochester, Rochester, N. Y. Twenty prospective employment managers sent to the university by manufacturers having war contracts are taking six weeks' intensive training in the practice and theory of employment management. Fifteen Rochester factories are providing the laboratory work and assisting the university in training these men. The course is given at the express request of the Industrial Service Sections of several of the departments at Washington. It is desired that manufacturers take a hand in the development of this movement and send students to the university on their own initiative. Those who wish to apply to send men to one of these courses should write to Employment Managers Division, 5207 New Interior Bldg., Washington, D. C. Courses will also be opened at Harvard University, Boston, Mass., in cooperation with the Massachusetts Institute of Technology. Applications for these courses may also be made immediately. The Government, having recognized the necessity for training men in the science of production and industrial management, should receive the fullest cooperation from all manufacturers who realize the need of training one or more young men as employment managers.

* * *

The War Trade Board, at Washington, D. C., has just published a complete list of all the firms in neutral countries listed in the Enemy Trading List and with whom citizens of the United States are not permitted to do business. The book may be obtained from the Government Printing Office, Washington, D. C. The publication is known as "Trading with the Enemy—Enemy Trading List Revised to March 15, 1918—No. 2."

TRAINING MECHANICS FOR ARMY SERVICE

Last February the Secretary of War appointed a Committee on Education and Special Training, to take charge of the training of 90,000 men of the National Army for technical and skilled work of various kinds. So rapidly has the committee proceeded that twenty-five schools are now under contract to take the men; fourteen have begun their work and 7500 National Army men are under instruction. The number of schools will be increased until 30,000 men can be instructed at one time. The courses are of eight weeks' duration, and the final number of 30,000 men (for army needs as now planned) will go to the schools September 1.

The institutions include engineering colleges, universities, and mechanics' institutes, while in one city the public school system is being used. Institutions that can accommodate at least 500 men are preferred, while one school expects to take 2500 men. The number of courses given at an institution depends on the number of students, character of school equipment, and location. Army officers will be placed at each school, and military drill will be carried along simultaneously with the technical instruction. The technical staff will be supplied by the institution. At present the following courses are arranged for: auto driving and repair, bench woodworking, general carpentry, electrical communication (telephone and telegraph work), electrical work, forging and blacksmithing, use of gas engines, machine-shop work, and sheet-metal work.

The men at the schools are National Army men who have volunteered for this special training and go to the schools directly from their homes. To insure proper assignment of schools, however, all men are sent first to "reservoir" schools, where they are tested by qualified men and then assigned to the proper schools. The aim is to push men along as fast as their abilities warrant; journeymen machinists, for example, will immediately be put on highly specialized work, such as airplane repairs.

* * *

MACHINISTS WANTED FOR GOVERNMENT WORK

The Watervliet Arsenal, Watervliet, N. Y., advises that it is in urgent need of machinists, and calls upon patriotic machinists who are not now engaged upon work necessary for the conduct of the war to apply to the Commanding Officer, Watervliet Arsenal, Watervliet, N. Y. It should be understood that men in plants and establishments manufacturing machine tools, munitions of war, or other material directly necessary for the successful conduct of the war are not wanted, but only skilled mechanics who are now engaged in industries that for the time being are not essential to the winning of the war. There must be thousands of men in this class who would be willing to put their services at the command of the Government for the successful winning of the war, at rates of pay which will prove satisfactory; details regarding this matter will be furnished by the Arsenal to those interested upon application.

* * *

MAY MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

At the May meeting of the New York Section of the American Society of Mechanical Engineers, the subject of labor turnover was discussed. A number of speakers representing the shipping, airplane, ordnance, and machine tool industries dealt with the subject in brief addresses. The machine tool industry was represented by L. D. Burlingame, industrial superintendent, Brown & Sharpe Mfg. Co., Providence, R. I., who spoke particularly on labor turnover in connection with the employment of women. The importance of training men and women for the work in machine shops and other factories was particularly emphasized. Several representatives of the Federal Government also spoke on the efforts made by the Government to regulate labor conditions, and information was given out indicating that the Government will shortly determine standard wages for various industries in order to prevent the shifting of labor from one shop to another, or from one locality to another.

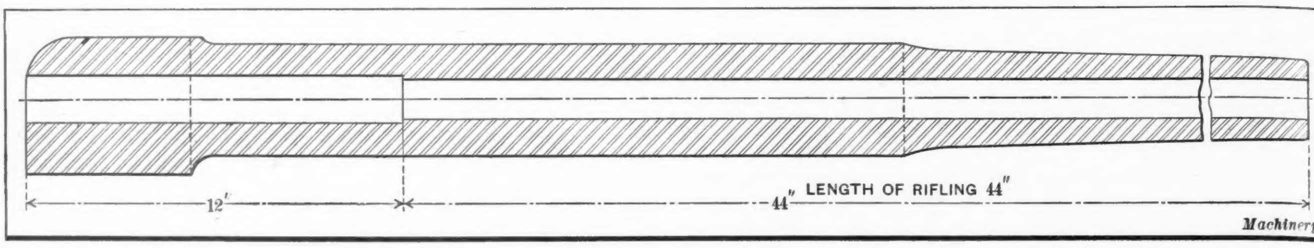


Fig. 1. Barrel of One-pounder Gun

BROACHING OPERATIONS ON ONE-POUNDER GUNS

BY FRANCIS J. LAPOINTE[1]

The broaching machine shown in Fig. 2 was developed by the J. N. Lapointe Co., New London, Conn., for broaching the breech opening and also the rifling grooves of one-pounder guns. Special tool equipments and fixtures are provided for each broaching operation so that it is possible to broach the breech opening and the rifling grooves on the same machine. The design of the fixtures is such that the change from one operation to the other can be made very quickly.

In Fig. 2 the machine is shown with the fixture and a one-pounder gun mounted in place ready for broaching the rifling grooves in the barrel. The same fixture can also be adapted for broaching the breech opening. The broaching of the rifling grooves is done in two operations by the use of a roughing and a finishing broach. The actual length of rifling is 44 inches, as will be noted by referring to Fig. 1.

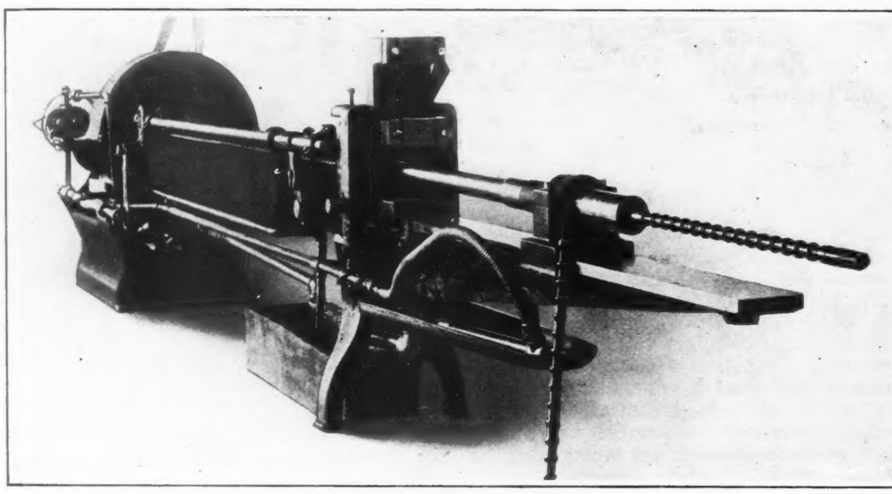


Fig. 2. Special Broaching Machine with Fixture and One-pounder Gun in Place Ready for broaching Rifling Grooves

Fig. 4 shows an enlarged section of the rifling grooves, which are approximately 0.015 inch deep and are twelve in number. The spiral formed by these grooves is right-hand and the lead is one turn in 40 inches. This rifling operation is accomplished by means of a master bar which gives the initial spiral to the cutting tool. The broaches used are also milled to correspond with the lead required. The master spiral bar is pulled by means of a roller thrust bearing and operates through a spiraling block that causes the bar to rotate. The gun is mounted on a carriage and clamped so as to hold it in perfect alignment and also prevent it from revolving. By referring to Fig. 2, it will be noted that there is a large flexible tube and pipe in the oil-pan under the front end of the machine. The pipe is slipped over the end of the broach and into the bore of the gun which at this end is large enough to admit the pipe. The broach is also provided with oil-channels so that every pocket between the cutting teeth of the broaches is filled with oil as it enters the work. The oil is constantly agitated by the high pressure under which it is forced. This results in a very smooth finish, as it prevents the chips from being cut dry and welding to the face of the teeth. The time required for broaching the rifling grooves is approximately fifteen minutes.

Fig. 3 shows the front end of the broaching machine with the fixtures and work mounted in position for broaching the breech opening. The work *D* rests on the bottom *F* of tilting head *A* and is held in place by clamps *B*. The tilting head *A* can be thrown forward or allowed to pivot on pin *I* to give the proper angle for broaching the tapered portion of the breech opening. The casting *G* is the fixture proper which is bolted to the end of the machine *C*. *H* is the broach carriage and *E* is a section of the broach.

Fig. 5 shows the eleven different operations required in finishing the breech opening, starting from a round hole

[1]Address: Care of J. N. Lapointe Co., New London, Conn.

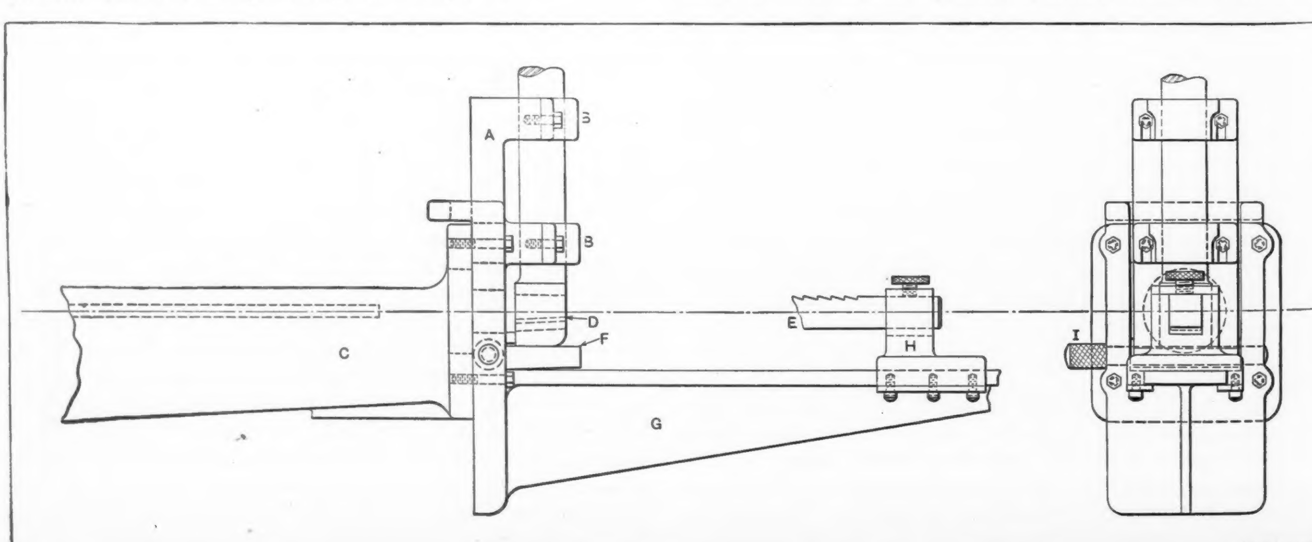


Fig. 3. Front End of Broaching Machine with Fixture and Gun-barrel mounted in Place for broaching Breech Opening

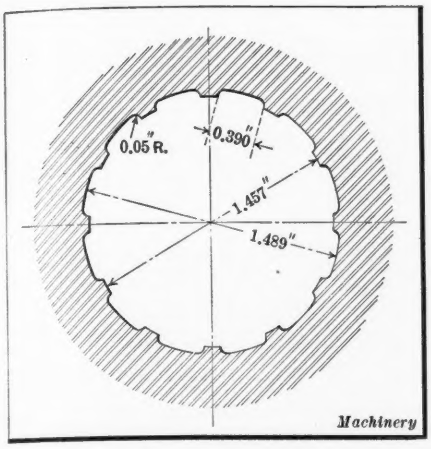


Fig. 4. Section of Gun-barrel which has Twelve Right-hand Spiral Grooves of Uniform Twist making One Turn in Forty Inches

2.5 inches in diameter. This hole is bored at an angle of approximately 5 degrees and the first nine operations are performed with the work held at this angle. The dimensions show the amount of material removed at each operation. It will be noted that on the first five operations the width of the rough-broached hole remains the same, namely 2.340 inches, and that the stock removed is all on the top and bottom. Operation 6 is a sizing operation finishing the width of the hole which represents the size between the two keys on the finished pieces. Operations 7, 8, and 9 are confined to removing material on the width of the hole stepping round the two solid keys, the ninth operation being a sizing operation which finishes the two keys. Operations 10 and 11 are accomplished by means of a T-shaped broach guided against a tapered block. Fig. 7 shows the eleven broaches employed. In this illustration is also shown a steel block that has been broached with this set of tools. The finished size of this broached hole is 2.756 by 2.857 inches. Fig. 6 shows the inside of a finished barrel as it appears when viewed from one end.

* * *

EFFECT OF COPPER IN MEDIUM-CARBON STEEL

In a paper by R. Hayward and A. B. Johnston, of the Massachusetts Institute of Technology, read before the American Institute of Mining Engineers, it was stated that copper increases the tensile strength and hardness, but lowers the elon-

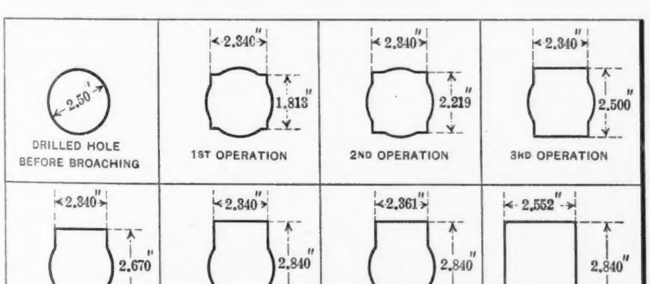


Fig. 5. Eleven Broaching Operations required in finishing Breech Opening

gation of the steel; in fact, copper steels closely resemble steels containing equivalent percentages of nickel as regards tensile strength, resistance to shock and corrosion, and hardness. Copper also lessens the brittleness of steel containing 1 per cent carbon.

These conclusions were obtained from tests carried out on bars of steel having the following analysis: carbon, 0.38 per cent; phosphorus, 0.012 per cent; manganese, 0.57 per cent; sulphur, 0.03 per cent; and copper, 0.86 per cent. These steels, for the purpose of comparison, were termed high-copper steels. Tests were also conducted on bars containing 0.03 per cent copper, 0.048 per cent sulphur, 0.59 per cent manganese, 0.053 per cent phosphorus, and 0.365 per cent carbon, which were termed low-copper steels. Except for one set of bars, which was given a higher temperature through an error, all the bars were heated from 845 to 865 degrees C. and then cooled. One set was let cool in the furnace over night, another set was cooled in air, and the others were quenched in water, replaced in the furnace, and drawn to different temperatures.

The high-copper bars, as forged, had a yield point of 60,900 pounds per square inch, and the low-copper bars 46,600 pounds. The high-copper bars cooled in the furnace had a yield point of 52,900 pounds, and the low-copper bars a yield point of 45,800 pounds. The yield point of the bars was increased by the heat-treatment, reaching 136,900 pounds in the case of the high-copper bars that had been drawn to 455 degrees C. The ultimate strength of the bars was increased from 92,600 pounds to 190,800 pounds in the case of the high-copper bars drawn to 360 degrees C., and from 83,200 pounds to 136,300 pounds in the case of the low-copper bars. The ultimate strength of the bars cooled in the furnace, however, was lowered to 86,530 pounds and 78,130 pounds, respectively. The bars heated and cooled in the furnace also had a lower percentage of reduction than the forged bars; this reduction was increased in the case of the bars heated and drawn to 580 degrees, but was reduced in the case of all the others. The percentage of elongation was also increased by the heat-treatment, except in the case of the bars heated and drawn to 360 degrees C., when it was greatly reduced. The microscopic study showed that, for the same treatment, high-copper steel is finer grained than low-copper steel, and the quenched and drawn specimens of high-copper steel are slightly more martensitic. To what extent copper in steel will prove to be of importance in practical engineering is still problematical, but the investigations made are, nevertheless, of interest.

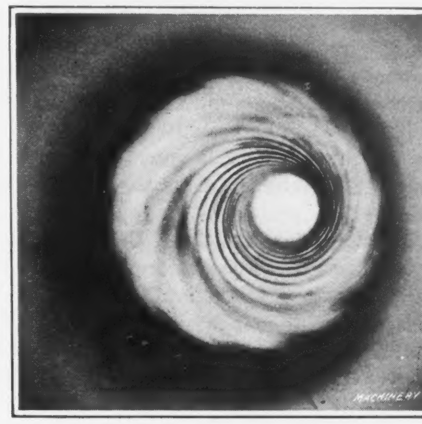


Fig. 6. Inside of Finished Barrel as it appears when viewed from One End

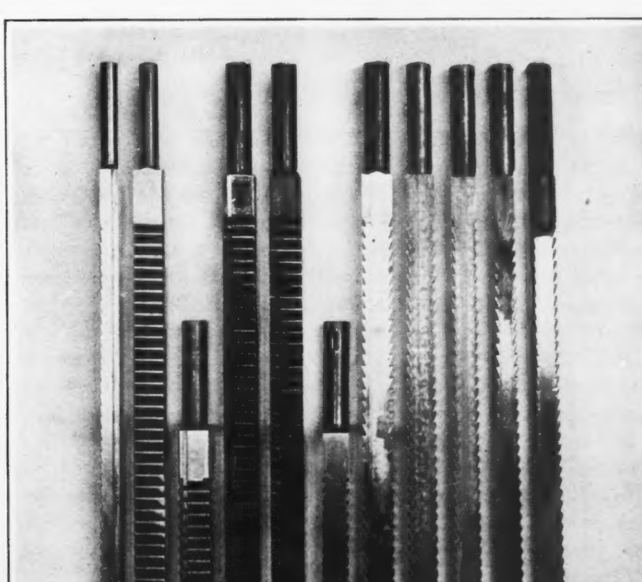


Fig. 7. Broaches employed in Eleven Broaching Operations

GRAPHIC USE OF LOGARITHMS

BY G. G. STEVENSON[1]

Logarithms are a valuable aid to engineers and draftsmen, but often they are not used to the greatest advantage. In the graphic solution of problems they are almost invaluable. A problem involving a number of variables can be drawn into chart form so that anyone can obtain correct results, although he may not understand the mathematical processes involved. Such charts are especially valuable for placing mechanical data in the hands of estimators, salesmen, etc. When more than two factors are involved, these charts are by far the most convenient method of solving a problem, or determining unknown factors. For instance, by means of the chart shown in Fig. 1, the capacity or lift of a pump or the horsepower of its motor may be readily found if two of these factors are known. As an example, suppose that it is required to find the horsepower of the motor that will drive a pump so that it will deliver 45 gallons a minute against a 95-foot head. By placing a straightedge, as shown by the dotted line, so as to intersect 45 on column *A* and 95 on column *C*, the point 4 on column *B*, where it is intersected by the straightedge is the horsepower required.

Probably the one thing that tends to discourage a more general use of these charts is the fact that they appear difficult to draw. This assumption, however, is wrong. Any convenient length may be taken for two of the columns, say *A* and *C*, which are then divided logarithmically. Several methods for doing this have been published but as a rule they are too complicated and roundabout to be practical. A simple and easy way where logarithmic paper is available is shown in Fig. 2. The logarithmic paper is placed at such an angle that the two extreme divisions desired just coincide with the horizontal extensions of the ends of the line to be divided; then with the T-square the points needed are projected to the line. If more convenient, a slide-rule may be used. This is done by multiplying the logarithm of each number to be located by the length of the whole line. In other words, the logarithms found are for a line one inch in length; then the points can be easily located by the use of a decimal scale.

Perhaps the easiest way to find the lateral location of the middle scale in this problem is to take, on the outside columns, two sets of numbers that can be conveniently used and the products of which are equal (for instance, 2 times 100 and 20 times 10). Join point 2 on one column *A* to 100 on the other column *C* and 20 on the first column *A* to 10 on the other column *C*. The position of the middle column *B* is at the intersection of these lines. Of course the scale of the line is determined by the efficiency of the machines, the factor of safety desired, etc. In the example given, the horsepower must be figured for both the maximum and the minimum requirements to determine the length of the center scale.

The chart shown in Fig. 1 represents a very simple case. Complications set in as soon as more factors are involved, but by applying a little reasoning almost any problem can be worked out by this method. The chart shown could, for instance, be drawn with several vertical or curved lines representing pumps of various efficiencies and horsepowers required for pumping different liquids, etc.

[1]Address: 420 E. Main St., Evans Apts., Fort Wayne, Ind.

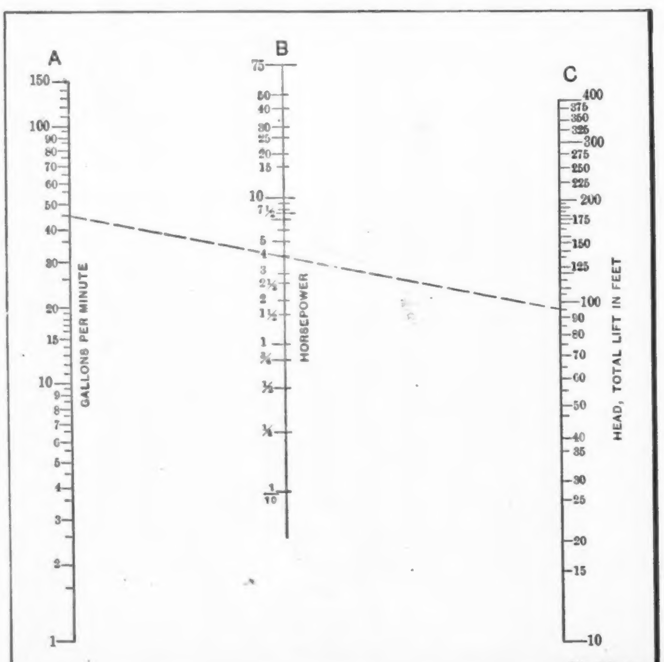


Fig. 1. Chart for finding Horsepower or Capacity of a No. 33A Pump

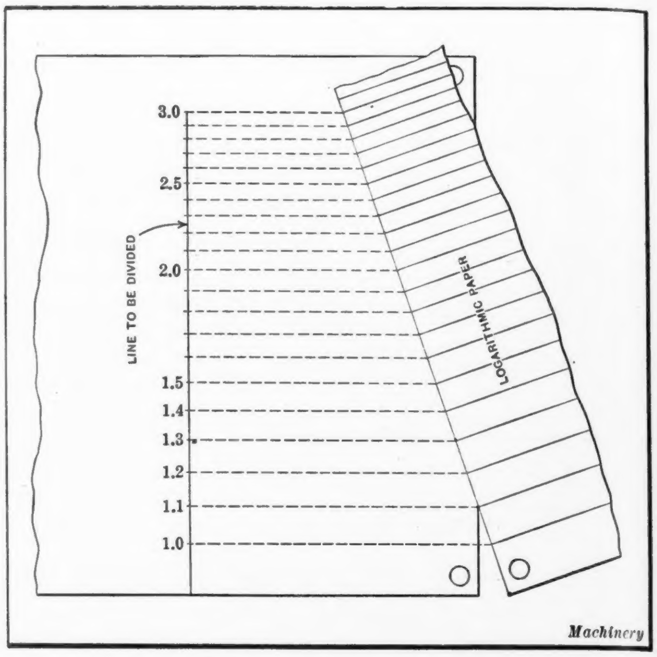


Fig. 2. Method of dividing a Line logarithmically

* * *

EFFECT OF FLANGES ON CAST-IRON CHANNELS

Tests made at the University of Wisconsin show that the flanges add little to the strength of cast-iron channels but have a marked effect on the stiffness of the section. All the channels tested were made of gray iron and had a tensile strength of 28,950 pounds per square inch. They had round ends, the centers of the ends coinciding with the centroidal axis of the section. The value of the polar moment of inertia was calculated with respect to this axis and, together with the area, was figured for the actual cross-section.

In the case of a channel with very small flanges, the ultimate twisting moment of which was 21,830 inch-pounds and the polar moment of inertia 18.6, the twisting moment when the first crack appeared was 19,690 inch-pounds. When it was assumed that only the 6-inch web was affected, the twisting moment was 18,940 inch-pounds; when the material in the flanges was included but was assumed to be revolved through 90 degrees, to form a deep narrow rectangular section, the twisting moment was 22,860 inch-pounds. In a channel with a 3¾-inch flange and a 6-inch web, which had an ultimate twisting moment of 31,070 inch-pounds and a polar moment of inertia of 53.92, the twisting moment when the first crack appeared was 31,070 inch-pounds. Assuming that only the web was affected, the twisting moment was 23,550 inch-pounds; when the material in the flanges was included but was assumed to be revolved through 90 degrees, to form a deep narrow rectangular section, the twisting moment was 44,500 inch-pounds.

* * *

A consular report states that tungsten ores have been exported from China to a considerable extent during recent months. When the trade in this ore began, its value was not realized by the sellers, who sold it as iron ore to the Japanese; at the present time the price is stated to be $32 per hundred pounds at Canton. Much of this ore comes from interior provinces, and in one case it is carried by men on the shoulders for a distance of sixty miles.

OBITUARIES

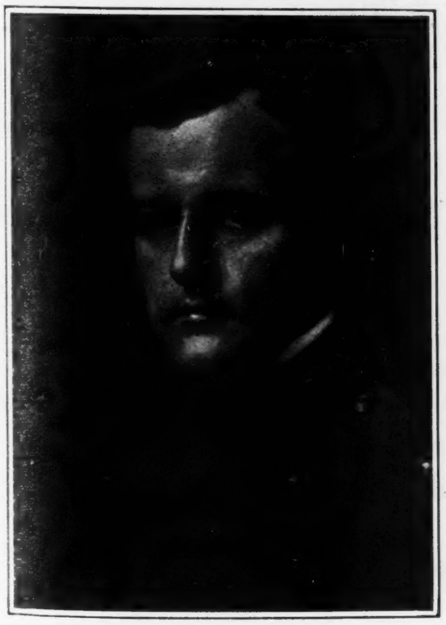
CLAYTON C. INGERSOLL

Lieutenant Clayton C. Ingersoll, a son of Winthrop Ingersoll, president of the Ingersoll Milling Machine Co., of Rockford, Ill., was killed in an airplane accident in France on April 26. Lieutenant Ingersoll was twenty-two years old, and his winning personality endeared him to a wide circle of friends. Educated at Lake Forest Academy and Cornell University, he received his military training at Fort Sheridan and at the aviation fields in Toronto, Canada, and Fort Worth, Texas. While he was stationed at Mineola, Long Island, before embarking for France last February, his engagement to Miss Mary Katherine Nelson, of Rockford, was announced. Lieutenant Ingersoll is survived by his parents, one brother, and two sisters.

Eben Boye, who was in the employ of Manning, Maxwell & Moore, 119 W. 40th St., New York City, for many years, died suddenly, after undergoing an operation, on May 13. He was associated with the company in Cleveland, Chicago, and Cincinnati, and for the last three or four years had been in the machinery department of the company in New York City.

EARL TRUMBULL WILLIAMS

Lieutenant Earl Trumbull Williams, of the 301st U. S. Field Artillery, and vice-president of J. H. Williams & Co., of Brooklyn, N. Y., was struck by a falling limb from a tree on May 6, while visiting friends in Northampton, Mass., and died the next day. Lieutenant Williams graduated from Yale University in 1910 and entered the business of J. H. Williams & Co., Brooklyn, N. Y., manufacturer of drop-forgings, which was founded by his father in 1883. When the company's plant at Buffalo, N. Y., began operation in 1914, Lieutenant Williams assumed charge as vice-president and was in active control until the summer of 1917, when he entered the officers' training camp at Fort Niagara. He received a commission as First Lieutenant in the 301st Field Artillery and was assigned to duty at Camp Devens, Ayer, Mass. Lieutenant Williams was an ex-member of Squadron A, New York, and a member of the Saturn and the Country Clubs of Buffalo. He is survived by his mother, brother, and sister.



FREDERICK REMSEN HUTTON

Frederick Remsen Hutton, for twenty-three years secretary of the American Society of Mechanical Engineers and president of the society in 1906, died May 14, aged sixty-five years. Professor Hutton was born in New York City, May 28, 1853. He graduated from Columbia College in 1873 with the degree of A.B., after which he entered the School of Mines, obtaining his degree in 1876. A year later he was appointed instructor in mechanical engineering in the university as an associate of the late Professor W. P. Trowbridge. Upon the death of Professor Trowbridge, in 1892, Professor Hutton was made head of the mechanical engineering department, which he continued to direct until 1907. At this time he resigned and was elected professor emeritus. For six years during his professorship he was dean of the Faculty of Applied Science. During Professor Hutton's association with the university he developed the mechanical laboratories until the equipment at present is the most complete of any technical school. Columbia conferred upon Professor Hutton in 1882 the degree of Ph.D., and on the occasion of its one hundred and fiftieth anniversary, in 1904, the degree of Sc.D.

Professor Hutton became secretary of the American Society of Mechanical Engineers in 1883, three years after its organization. He was appointed a member of the Conference and Building Committee of the United Engineering Society, which planned the Engineering Societies' building at 29 W. 39th St. He was also one of the Board of Trustees, which is the holding corporation for the United Engineering Society. In 1906, Professor Hutton was unanimously elected president of the American Society of Mechanical Engineers. At the close of Professor Hutton's administration as president of the society, he was appointed honorary secretary, as a token of appreciation of his unselfish and capable work in the society's interest—a recognition well deserved. In addition to his work for the society and at Columbia University, Professor Hutton has been an extensive contributor to scientific literature. His most important books, which have been widely accepted in the educational field in the United States and in England, are "The Mechanical Engineering of Steam Power Plants," "Heat and Heat Engines," and "The Gas Engine." He was the author of two of the most important monographs of the census of 1880, one covering machine tools and the other pumps and pumping engines. He was one of the collaborators in the preparation of the Century Dictionary, published in 1910, and the new International Encyclopedia of 1916. He has contributed extensively to the transactions of the society and has done considerable other literary work.

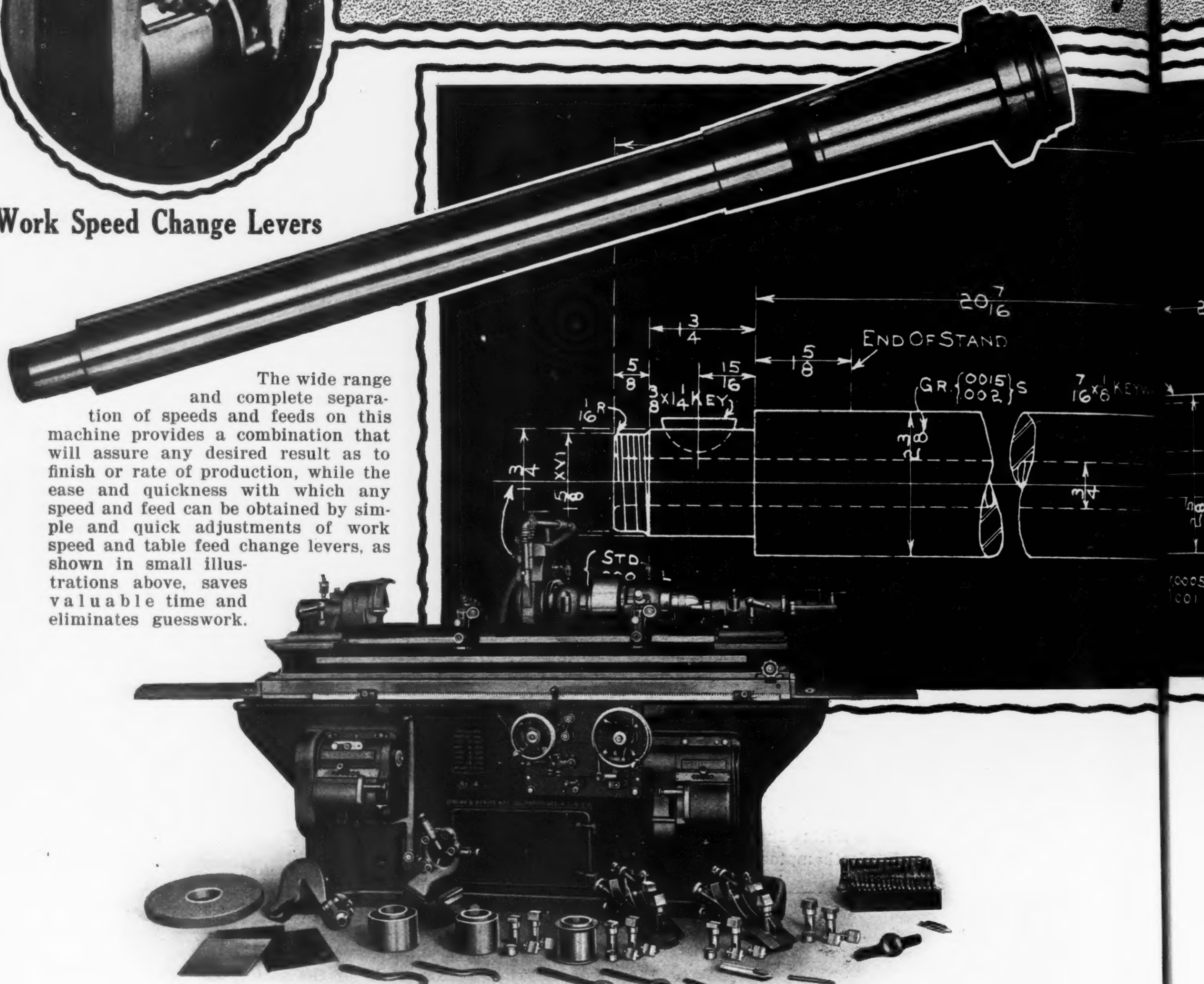
CAPTAIN RENÉ FENWICK

Captain René Fenwick, of the 31st Dragoons, French army, was killed at Locre, near Ypres, on the 28th of April, 1918, leaving a widow and three sons.

Captain Fenwick was the only son of Francis Fenwick, president of the Societe Anonyme des Etablissements Fenwick Frères & Cie., of Paris, a firm well known to all American machine tool manufacturers.

Correct Speed and F
on This Piece Easily a

Work Speed Change Levers



The wide range and complete separation of speeds and feeds on this machine provides a combination that will assure any desired result as to finish or rate of production, while the ease and quickness with which any speed and feed can be obtained by simple and quick adjustments of work speed and table feed change levers, as shown in small illustrations above, saves valuable time and eliminates guesswork.

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fulfill the various conditions to be met with in handling a wide variety of cylindrical grinding in a way that instantly appeals to both the operator and the production man. Work of large or small diameter, work which includes both large and small diameters, such as the piece shown above, or long slender pieces are all the same to the operator of one of these machines as far as accuracy and fast production are concerned. The wide range, complete separation and ease and quickness of obtaining work speeds and table feeds, while especially important, are but a few of the many features of these accurate and rapid machines.

May we tell you about them in detail? Send for Catalog 136.

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OFFICES: New York, N. Y., 20 Vesey St.; **Syracuse, N. Y.,** Room 419, University Block; **Rochester, N. Y.,** 415 Chamber of Commerce Building; **Pittsburgh, Pa.,** 2538 Henry W. Oliver Building; **Philadelphia, Pa.,** 1103-1105 Liberty Bldg.; **Chicago, Ill.,** 626-630 Washington Blvd. **CANADIAN REPRESENTATIVE:** Canadian Fairbanks-Morse Co., Ltd., Toronto, Montreal, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

PERSONALS

C. L. Campbell, formerly with the C. A. Strelinger Co., Detroit, Mich., is now employed in the Machinery Sales Department of the Cadillac Tool Co., Detroit, Mich.

C. B. Leeds, formerly with the National Automatic Tool Co., Richmond, Ind., is now employed in the Machinery Sales Department of the Cadillac Tool Co., Detroit, Mich.

E. L. Steinle, who was eastern representative for the Steinle Turret Machine Co., is now associated with the Machine Tool Engineering Co., Inc., 149 Broadway, New York City.

V. P. Signorelli, who was formerly secretary and assistant treasurer of the Southwark Foundry & Machine Co., Philadelphia, Pa., is now office manager and auditor of the company.

R. W. Ellingham has resigned his position with the Bilton Machine Tool Co., Bridgeport, Conn., to enter the employ of the Heald Machine Co., Worcester, Mass., as works manager.

Charles Vickers has opened an office at 18 Dun Bldg., 110 Pearl St., Buffalo, N. Y., where he will carry on his business as consulting non-ferrous metallurgist and foundry adviser.

John G. Zummach, formerly chief of the Tool Designing Department with the Mitchell Motors Co., Racine, Wis., is now chief engineer and assistant factory manager with the Perfex Radiator Co., Racine, Wis.

A. P. C. Schramm, who has been chief engineer of the Klaxon Co., Newark, N. J., for the past five years, has opened an office as a consulting engineer at 276 Canal St., New York City. His specialty is electrical, industrial, and efficiency engineering.

D. M. Perrill, formerly advertising manager of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, now has a similar position with the Lyon Metallic Mfg. Co., Aurora, Ill., and is in charge of this company's advertising and sales promotion work.

Howard J. Walls, son of T. P. Walls, president of the T. P. Walls Tool & Supply Co., Inc., 75-77 Walker St., New York City, who was one of the survivors of the *City of Athens*, which was sunk on April 30 by a collision with a French cruiser off Atlantic City, has enlisted in the Marine Corps.

J. M. Riordan, until recently sales engineer of the Grant Lees Gear Co., Cleveland, Ohio, and formerly a representative of the Fellows Gear Shaper Co., of Springfield, Vt., in the central states, is now connected with the sales organization of the Cleveland Milling Machine Co., Cleveland, Ohio.

Wendell P. Norton, works manager for the Hendey Machine Co., Torrington, Conn., and superintendent of the factory for twenty-eight years, has resigned his position, but has not yet announced his plans for the future. Mr. Norton is the inventor of the Norton lathe, manufactured by the Hendey Machine Co.

L. L. Newton, who has been for several years sales manager and secretary of the Luther Grinder Mfg. Co., Milwaukee, Wis., has resigned his position to become manager of the Stegeman Motor Car Co., of Milwaukee. Frank S. Hyland, for several years a member of the Luther sales force, will take Mr. Newton's place.

I. G. Stutsman has been appointed manager of the Milwaukee office of Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City. Mr. Stutsman was for several years superintendent of the frog and switch shop of the Chicago, Milwaukee, and St. Paul Railroad at Tomah, Wis., and was more recently master mechanic for the Four Lakes Ordnance Co., Madison, Wis.

E. C. Peck, who has been in charge of the Cleveland Twist Drill Co., Cleveland, Ohio, for the past eighteen years as general superintendent, has been made Lieutenant-Colonel in the National Army, and is now chief of the Gage Section of the Engineering Bureau in the Ordnance Department, with headquarters at 451 Pennsylvania Ave., Washington, D. C. The Cleveland Twist Drill Co. has released Mr. Peck to the Government, for patriotic reasons, for the period of the war.

Howard Coonley, president of the Walworth Mfg. Co., Boston, Mass., was selected by Charles M. Schwab to be a vice-president of the Emergency Fleet Corporation and head of the Administration Department. Mr. Coonley is a graduate of Harvard University. In 1914, he accepted the presidency of the Walworth Mfg. Co., and in August, 1917, he reorganized the company and purchased the plant of the National Tube Co. at Kewanee, Ill., manufacturer of fittings, valves, and tools for water, steam, and gas work. Seventy-five heads of departments at the Boston works entertained him at an informal luncheon and presented him with a silver desk set as an expression of their respect and affection.

Charles A. Coffin, chairman of the board of directors of the General Electric Co., Schenectady, N. Y., and head of the Franco-American Clearing House in New York, has been presented with the cross of an officer of the Legion of Honor by the French Government. The presentation was made by the ex-assistant French war secretary, Justin Godart, in recognition of his work at the Franco-American Clearing House, which is now under the direction of the Red Cross, and for his efforts to develop a system of scholarship for Americans in French universities. He succeeded Judge Robert S. Lovett as the head of the committee on cooperation appointed by the Red Cross to negotiate with independent relief organizations. As head of the executive committee of the War Relief Clearing House, he has been very active in war service.

* * *

GASOLINE VAPORS

The danger of gasoline vapors is pointed out in an article in *Safety Engineering*. Unless an ample current of air at considerable velocity is passing, gasoline should not be used to clean an engine or other machinery. Even if there is sufficient air to sweep away the vapors as they are given off, open lights should always be kept at a safe distance, and on the intake side, so that the vapor cannot be carried to them. Many gasoline engines are built with cavities or enclosed spaces, which may be full of gasoline vapor; men using open lights when inspecting or repairing such engines have been severely burned by the ignition of these vapors. To guard against such accidents, all cavities should be blown out with compressed air or steam. If neither is available, the cover should be removed and the vapors fanned out.

Seemingly empty gasoline cans or tanks are probably more dangerous than those filled with gasoline. Usually all the gasoline is not drained off, so that which is left will vaporize, and as this vapor mixes with the air in the can, an explosive mixture may be formed. When a can is being filled, this mixture is forced out and may explode if a flame or spark is near the opening.

* * *

CONVENTION OF THE NATIONAL ASSOCIATION OF MANUFACTURERS

The twenty-third annual convention of the National Association of Manufacturers held at the Waldorf-Astoria Hotel, New York City, May 20-22, was devoted largely to subjects connected with the war. Many addresses indicated how manufacturers should promote the national war program. The conservation of man power, labor supply, mechanical reorganization, fuel, transportation, industrial housing, export trade developments, and many other subjects of vital importance were comprehensively treated with particular reference to the manufacturers' needs. Stephen C. Mason of the McConway & Torley Co., Pittsburg, Pa., was elected president to succeed the late Colonel George Pope. Contrary to the usual custom, the association held no annual banquet, the money usually spent for this purpose having been devoted to Liberty Loan subscriptions. An exhibition devoted to "Conservation of Man Power" was arranged in connection with the convention.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC. REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly on the 1st at New York, N. Y., for April 1, 1918.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of MACHINERY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press	140-148 Lafayette St., New York
Editor, Erik Oberg	" " " " "
Managing Editor, None	
Business Managers { Alexander Luchars, President	" " " " "
Business Managers { Matthew J. O'Neill, Gen'l Manager	" " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press	140-148 Lafayette St., New York
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "
H. L. Ketchum	" " " " "
E. Y. Urban	" " " " "

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 1st day of April, 1918.

THOMAS R. WILLIAMS,

(SEAL) Notary Public, Bronx County, No. 61.
Certificate Filed New York County, No. 419.
(My commission expires March 30, 1919.)

COMING EVENTS

June 20-22—Fifth annual convention of the American Drop Forge Association held at the Iroquois Hotel, Buffalo, N. Y. E. B. Horne, "The American Drop Forger," 108 Smithfield St., Pittsburg, Pa., secretary.

June 25-28—Annual meeting of the American Society for Testing Materials, at the University of Pennsylvania, Philadelphia, Pa.

June 26-28—Annual meeting of the American Institute of Electrical Engineers, at Atlantic City. Secretary's address, 29 W. 39th St., New York City.

June 27—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

October 7-12—Joint convention of the American Foundrymen's Association and the American Institute of Metals in Milwaukee, Wis. Concurrent with these meetings there will be an exhibition of foundry equipment, machine tools, and accessories.

SOCIETIES, SCHOOLS AND COLLEGES

Clarkson College of Technology, Potsdam, N. Y. Catalogue for 1918, containing calendar and courses of study.

Northwestern University, Northwestern University Bldg., Chicago, Ill. Catalogue 1917-1918, containing calendar for 1918-1919, courses of study, and other information relating to the university.

Hebrew Technical Institute, Stuyvesant and Ninth Sts., New York City. Catalogue for 1918, containing calendar, courses of study, and other information relative to the work of the institute.

Massachusetts Institute of Technology, Cambridge, Mass. Catalogue for 1917-1918 containing a statement of the requirements for admission, description of the courses of instruction, and other general information about the institute and its educational activities.

Y. M. C. A. National War Work Council, 347 Madison Ave., New York City. Pamphlet entitled "The Association's Obligation in View of Industrial Conditions Created by the War," comprising the report of a conference held under the auspices of the Committee on Work in War Industries of the National War Work Council.

NEW BOOKS AND PAMPHLETS

Lime in 1916. By G. F. Loughlin. 29 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

A Study of the Heat Transmission of Building Materials. By A. C. Willard and L. C. Lichty. 60 pages, 6 by 9 inches; illustrated. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 102.

Military Slide-rule. By J. J. Clark. 16 pages, 6 by 9 inches; 3 illustrations. Published by G. W. Richardson, 4210 W. 24th Place, Chicago, Ill. Price, 25 cents.

This book describes the operation of the military slide-rule for the solution of triangles in computing the range of the target.

Aircraft Mechanics Handbook. By Fred H. Colvin. 402 pages, 5 by 7¼ inches; 192 illustrations. Published by McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $3, net.

This book is designed to aid the thousands of mechanics who are needed to inspect, adjust, and repair the large air fleet being prepared in this country. The first six chapters are devoted to various phases of airplane construction, after which the various types of engines are described; the common troubles likely to arise are dealt with and their remedies are given. Then follow chapters on the training machines, instruments required, the Lewis machine gun, and British training methods. In the last two chapters are given tables, diagrams, and terms used in aeronautics.

Principles of Mechanism. By Walter H. James and M. C. Mackenzie. 242 pages, 5¼ by 7½ inches; 247 illustrations. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $1.50.

This book, which is one of the Wiley technical series, has been written especially for use in evening technical schools, trade schools, mechanic arts high schools, etc., where it is desired to teach the subject thoroughly without going into a highly mathematical treatment. Typical problems are solved throughout the text, and at the end is an appendix of 22 pages, which contains 110 problems for the students to solve. The nine chapters into which the book is divided are headed as follows: General Definitions; Revolving and Oscillating Bodies; Transmission of Motion by Means of Cylinders, Cones, and Disks; Gears and Gear Teeth; Belts, Ropes, and Chains; Inclined Plane, Wedge, Screw, Worm, and Wheel; Cams; Simple Wheel Trains; and Links and Linkages.

Steel and Its Heat-treatment. By Denison K. Bullens. 483 pages, 6 by 9 inches; 285 illustrations. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $4.

This is the second edition of the author's work, which has been thoroughly revised and broadened to include additional information of a practical nature. The purpose of the book is to consider more completely the practical aspect of the heat-treatment of steel than has been done in many works in the past that have been written by theoretical metallurgists. The work covers a wide range of subjects, including the testing of steel; heat generation; heat application; forging; structure of steel; annealing; hardening; tempering; carburizing; casehardening; carbon steels; nickel steels; chromium steels; chromium nickel steels; vanadium steels; manganese steels; silicon steels; tungsten steels; molybdenum steels; high-speed steels; tool steel and tools; miscellaneous heat-treatments; pyrometers; and critical range determinations. The book may well be recommended to anyone who wants to study the heat-treatment of various kinds of steels, both from a theoretical and a practical point of view, but it might be mentioned that the work is by no means a primer on the subject, and that the theoretical side has been given quite extended consideration, so that the practical man should not attempt to study the work except with this idea in view.

Modern Locomotive Valves and Valve Gears. By Charles L. McShane. 340 pages, 4¾ by 7¼ inches; 113 illustrations. Published by Griffin & Winters, New York Life Bldg., Chicago, Ill. Price, $2.50.

This book covers the subject of valves and valve gears now in general use and contains much new, up-to-date, practical matter. The movements of the various types of valves and valve gears are explained so as to be as readily understood by the apprentice as by the experienced mechanic. For this reason, considerable space is devoted to definitions and elementary or fundamental principles. Balanced valves are then discussed, there being a description first of the valve and then of the different types, especial attention being paid to the more recent designs. Piston valves are discussed in the same manner, the advantages and disadvantages of the various types being shown. In the chapters dealing with valve gears, considerable space is given to the Walschaert gear, which is so extensively used at the present time. After the principles and construction have been carefully described, methods of handling the engine in case of accidents to the gear are given. Then follow descriptions of the Kingan-Ripkin valve gear device, designed to overcome the slow action of the combination lever, and of the Davis variable lead attachments. The closing chapters of the book deal with the Baker, Southern, and Young valve gears. A well-prepared index with cross-references adds to the value of the book by making it possible to find any item without loss of time.

Managing a Business in War Time. Two volumes; 402 pages, 5 by 8 inches; 81 illustrations; 5 tables. Published by A. W. Shaw Co., Chicago, Ill.

These timely volumes are divided into two parts each. Part I describes England's war-time experiences, each chapter being written by a man prominent in the British industrial world, who tells how he solved the problems he met. Part II was prepared by the editorial staff of "System" and gives hints from the experience war work gave England. Part III, which was obtained from various sources, describes methods by which American business may meet war-time conditions. Part IV deals with some problems that will have to be met after the war, as seen by men who have made a careful study of American industries. The books are full of methods by which all kinds of war-time problems may be solved; but no sales methods are given, the editors feeling that this subject should be avoided entirely. The titles of the various chapters are: Adjusting a Business to War-time Conditions; What American Business Men can Learn from British Experience; War-time Management Methods that have Won Success; How America can Meet War-time Business Conditions; How England is Meeting the Labor Problem; The Problem of Manpower in War Time; Running a Store in War Time; How England Met Six Important War-time Business Problems; Hints on Handling War-time Business; The Biggest War-time Tasks Facing American Business Men; Some Lessons the War Taught England; What can the Business Man Learn from the Soldier?; Pointers Gained Manufacturing Munitions; How Working Hours Affect Output; A Managerial By-product from Munition Work; Training the Boy Worker; The Six Most Important Factors in Meeting War-time Conditions; Food and the War Worker; Women and War Work; How will the War Affect Business?; The Probable Effect of the War upon Prices; How to Get the Most from the Farm; The Twenty Men Behind the Lines; Motor Trucks; A War-time Ally; A Short-cut in Financing; Our Flag: Its Laws and Customs; How to Sell to the Government; More Production with Fewer Men; Financing During the War; War-time Buying Problems; Munitions You can Make with the Equipment You Have; Where will European Competition Find Us Weakest?; What Chance has America after the War?; South American Trade Knocks at the Door; Preparing for the Trade Contest; What I Learned in Europe.

NEW CATALOGUES AND CIRCULARS

Pannier Bros. Stamp Co., Pittsburg, Pa. Catalogue of steel stamps for marking tools, dies, machines, etc.

Lewis M. Ellison, 214 W. Kinzie St., Chicago, Ill. Circular describing and giving price lists of Ellison draft gages.

American Pneumatic Chuck Co., Chicago, Ill. Circular illustrating and describing American air-operated chucks.

National X-Ray Reflector Co., Chicago, Ill. Circulars illustrating "X-ray" reflectors and other lighting devices.

Malm Engineering Co., Philadelphia, Pa. Circulars descriptive of rubber punching machines and gasket trimming machines.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 100, descriptive of portable forges for toolmakers, machinists, boilermakers, blacksmiths, etc.

Electrolytic Oxy-Hydrogen Laboratories, 15 William St., New York City. Bulletin G, descriptive of the Levin oxygen and hydrogen generator.

Warner Elevator Mfg. Co., Cincinnati, Ohio. Bulletins 2850, 3100, and 3200, describing geared automobile elevators and traction elevators for freight service.

Ross Heater & Mfg. Co., 504 Mutual Life Bldg., Buffalo, N. Y. Circular of Ross crosshead-guided expansion joints, multi-head water heaters, and surface condensers.

Terkelsen & Wennberg, 326 A St., Boston, Mass. Circulars of the T. & W. semi-automatic machine presses for composition molding and T. & W. tire wrapping machine.

Boston Gear Works, Norfolk Downs, Quincy, Mass. Catalogue F-8 of spur gears, miter gears, worm-gears, spiral gears, sprockets and chains, universal joints, and ball bearings.

Pond-Robinson Metal Saw Co., Ltd., 1204 Howard St., San Francisco, Cal. Circular outlining the noteworthy features of Robinson's high-speed metal saw for cutting hard metals.

Griscom-Russell Co., 90 West St., New York City. Bulletin 901, illustrating and describing the construction of the "Multiwhirl" cooler for cooling lubricating and quenching oils.

D. A. Hinman & Co., Sandwich, Ill. Leaflet descriptive of bar benders and Sandwich pumping outfits which have been built with especial reference to the needs of the contractor and builder.

Gisholt Machine Co., Madison, Wis. Circular illustrating and describing Gisholt 16-inch simplified lathe for manufacturing operations, and Gisholt 25-inch special boring lathe, showing application for 6-inch shells.

Gisholt Machine Co., Madison, Wis. Circular entitled "Help Win the War by Keeping up Production," illustrating the Gisholt universal tool grinder, and listing the savings which can be effected through its use.

A. M. Byers Co., Pittsburg, Pa. Circular of Byers wrought-iron pipe, showing a photomicrograph of the pipe magnified sixty diameters, which indicates how the slag contained in the iron prevents the pipe from rusting.

Foster Machine Co., Elkhart, Ind. Folder of the H. & M. thread miller, manufactured under the Holden-Morgan patents, illustrating and briefly describing the machine and showing the classes of work for which it is adapted.

Baldwin Locomotive Works, Philadelphia, Pa. Record No. 90, containing an article entitled "The Problem of Motive Power under the National Administration of Railroads," by Alba B. Johnson, president of the Baldwin Locomotive Works.

Ulrich Planfiling Equipment Co., Jamestown, N. Y. Circular of the Ulrich index clip for rolled drawings, "Planfile" for large sheets of cloth or tissue, "Planfile" drawer units for small sized drawings, and steel shelving for filing field and note books.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Pamphlet entitled "Satisfaction or—," treating of the subject of industrial drinking water systems and the application of "Nonpareil" cork covering for insulating pipe lines of drinking water systems.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Leaflet 250, illustrating and describing a light-weight, substantially built, hand magnet for the use of smelters and refiners, metal dealers, iron and brass foundries, machinists, and others in allied lines.

Western Machine Tool Works, Holland, Mich. (Hill, Clarke & Co., Inc., 156 Oliver St., Boston, Mass., agents). Catalogue 9, illustrating and describing in detail three lines of radial drilling machines in sizes from three to eight feet, inclusive.

Link-Belt Co., Chicago, Ill. Book 312, entitled "Link-Belt Silent Chain—the Efficient Drive for Machine Tools," describing the construction of Link-Belt silent chain and showing installations on various types of machine tools in a number of factories.

Evertite Nut Corporation, Detroit, Mich. Booklet describing the "Sta-lok" nut, a lock-nut which is so designed that it will lock onto the bolt more tightly the greater the strain placed upon it to unscrew it, unless a small nail is put into a keyhole provided for the purpose, to prevent a locking ball from acting.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1043, containing description and price list of Baehr flexible couplings, which are particularly suitable for use between a motor and the driven machinery, especially where the vibration of the machinery would have a damaging effect upon the motor insulation.

Walcott Lathe Co., Jackson, Mich. Circular of Walcott engine lathes, with quick-change gear-box, three-step cone, and double back-gears, in 14-, 16-, 18-, 20-, 26-, and 29-inch sizes; Walcott tool-room lathes; and improved taper attachment. The Walcott engine lathes are made with either English or metric lead-screws.

Wetmore Mechanical Laboratory Co., Milwaukee, Wis. Leaflet entitled "Wetmore Cutting Tools for Shell Manufacture," illustrating and describing special hand sizing taps, of both the solid and expanding types, for U. S. and British shells; expanding reamers for finish-sizing fuse holes of shells; and special lathe and boring tools.

Pennsylvania Engineering Works, Newcastle, Pa. Catalogue containing a series of views intended to convey in as brief a way as possible the class and

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"PRECISION"

BORING, DRILLING AND

MILLING MACHINE

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and as time goes on

ALWAYS BETTER

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scope of work in which this company specializes. Among the products illustrated are blast furnaces, hot metal mixers, converters, open-hearth furnaces, hot metal cars, and steel ladles.

Lewis-Shepard Co., 48 Binford St., Boston, Mass. Catalogue of the "Jicklift Master Truck," containing views of installations of this elevating truck in various factories, and specifications and dimensions of the different types. The catalogue is made the same size as a letter file folder and is provided with an index tab for convenience in filing.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Catalogue 43, illustrating and describing the H-P-M line of hydraulic valves and fittings. H-P-M hydraulic valves are divided into four classes, namely, operating, check, knock-out and safety. In addition to the standard line, a number of valves designed for special purposes are illustrated.

Benjamin Roman, solicitor of patents, 290 Broadway, New York City. Reference chart for machine designers, containing decimal equivalents of fractions of an inch, data relating to strength of materials, dimensions of standard machine screws, decimal equivalents of twist drill and steel wire gage, and formula for the solution of right-angled triangles.

Henry & Wright Mfg. Co., 760 Windsor St., Hartford, Conn. Catalogue of Henry & Wright drilling machines, illustrating and giving specifications for the various classes, which range from single-spindle machines to those having eight spindles. The catalogue also includes a chart of speeds and feeds for drilling, using both carbon steel and high-speed steel drills.

Fulflo Pump Co., 126 Opera Place, Cincinnati, Ohio. Booklet entitled "Scientific Lubrication of Cutting Tools," treating of the history of cutting tool lubrication, purpose of lubricating a cutting tool, volume of coolant necessary, water solutions as coolants, application of coolants, etc. It is claimed that the construction of the "Fulflo" lubricant pump is such that no clogging can occur and the pump cannot lose its prime.

Earle Gear & Machine Co., 4705 Stenton Ave., Philadelphia, Pa. Circular entitled "Economy in Cold-sawing," describing the "Lea Simplex" cold metal saw. A summary of the features of design of this machine is given, and the four sizes of both belt- and motor-driven types are illustrated, complete specifications of each size also being given. Illustrations are included showing this tool in actual service on a wide variety of work, as well as views showing the machine adapted for multiple cutting.

Foster Machine Co., Elkhart, Ind. Descriptive catalogue of turret lathes, devoted primarily to a study of increased production on the modern turret lathe. Illustrations and specifications of the Foster 1-B turret lathe are given, and, in addition, a number of examples of correct tooling for different classes of work are given, indicating the possibilities of the machine for rapid and accurate production. The tooling lay-outs are shown in line engravings, and halftone illustrations show the work to be produced.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Catalogue of LeBlond lathes, including screw-cutting engine lathes, quick-change engine lathes, rapid-production lathes, automobile manufacturers' lathes, heavy-duty turret lathes, plain chucking lathes, gap lathes, motor-driven lathes, crankshaft lathes, and lathes for special purposes. The catalogue contains a complete description of the various parts and tables of specifications giving the dimensions, capacities, feeds, speeds, etc., of the different sizes and types of lathes.

Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn. Quick-reference catalogue 16, illustrating and describing this company's chrome-nickel lathe tools with tool-steel bearings; shaper and planer tools; tool-holder for bench and watch lathes; boring-tool holders; boring-bars and internal threading tools; cutting-off tools; threading tools; side tools; vise hold-downs; lathe and milling machine dogs; high-speed steel cutters, etc. A price list of extra cutters is also given. The catalogue, which is of the vest-pocket size, will be sent free upon request.

Titanium Bronze Co., Inc., Niagara Falls, N. Y. Catalogue treating of high-conductivity copper castings, which are said to contain only three-tenths of 1 per cent of impurities, guaranteeing a minimum electrical conductivity of 75 per cent, which runs as high as 93 per cent. Photomicrographs are reproduced showing the relative amounts of impurities contained in electrolytic copper and titanium-treated copper, and the effect upon their conductivity. The catalogue also includes a table showing the effect of admixture of copper with specific quantities of various substances.

Rivett Lathe & Grinder Co., Brighton District, Boston, Mass. Catalogue illustrating and describing in detail the improved Rivett thread-cutting tool, an attachment for mounting on the toolpost block of the slide-rest of any standard engine lathe. This tool is adapted for cutting threads of six pitch and finer of any form excepting the square thread. The action of the cutter is clearly illustrated by the reproduction of views showing the development of a V-thread. The catalogue is illustrated with numerous halftone engravings which show the construction of the tool very clearly.

Fellows Gear Shaper Co., Springfield, Vt. Catalogue comprising treatise on the action of involute gearing. The subject has been treated in a simple way, without recourse to the use of higher mathematics, so as to be easily understood by the average shop man. The chapter heads are: Involute Spur Gearing and its Application; The Involute Curve and How it is Applied to Gear Teeth; Definitions of Gear Terms and Tooth Parts; Gear Tooth Systems and Advantages of Involute Gears; Generating Involute Gear Teeth and Interference in Involute Gears; The Gear Shaper Cutter as an Example of Correct Involute Action; Methods of Drawing Involute Tooth Curves; Tables of Gear Tooth Parts. This is the third edition, revised and enlarged, of this catalogue.

Ludlum Steel Co., Watervliet, N. Y. Catalogue of tool steel, 155 pages, 4¾ by 6¾ inches, comprising a treatise on the manufacture of steel and the use of various alloy elements. The book was compiled and written with the thought in mind that it is necessary for the user of tool steel and automobile steels to have a thorough understanding as to the uses of the various alloys used in the manufacture of steel, and the information given is the result of the company's extensive experience in the alloying of steels and comprises, in addition, a compilation of all the published information on the subject. An endeavor has been made to eliminate as far as possible the technical terms and explain the phenomena occurring in iron and steel in terms that the machinist will readily understand. The book deals with the effects of the alloys, change of properties, grain size, structure of steel, etc. A copy will be sent free upon request.

TRADE NOTES

Schodér & Lombard Stamp & Die Co., Inc., is now located in its new factory at 202-204 Center St., New York City.

Machine Tool Engineering Co., manufacturer of railway and machine shop tools and equipment, 149 Broadway, New York City, has been incorporated.

K. & Z. Automatic Screw Co., Defiance, Ohio, has opened a plant for the manufacture of screw machine products and is now in a position to undertake contract work.

Cincinnati Pulley Machinery Co., Cincinnati, Ohio, manufacturer of pulley lathes, is building a large addition to its shop, which will increase the present capacity to a considerable extent.

Wetmore Mechanical Laboratory Co., Milwaukee, Wis., manufacturer of special small tools, has removed its Canadian branch office from Toronto to the New Birks Bldg., Montreal, Canada.

Wadell & Bowen Co., Inc., 109 Tichenor St., Newark, N. J., is now being conducted under the firm name of G. F. Bowen Machine Co., George F. Bowen having acquired the interest of his co-partners in the business.

Bound Brook Oil-less Bearing Co., Bound Brook, N. J., has removed its western office from 308 Moffat Bldg., Detroit, Mich., to Room 1723, Ford Bldg., Detroit. The office is in charge of Harry J. Lindsley, western sales manager.

Defiance Screw Machine Products Co., Defiance, Ohio, has made plans for the erection of a three-story brick building which will be used as an office building, and also for a large two-story addition to the present factory.

Western Tool & Mfg. Co., Springfield, Ohio, has completed the erection of a one-story addition to its plant which will enable the company to take care of the increased demands for its vises, tools, hacksawing machines, and metal furniture.

Federal Machinery Sales Co., 12 N. Jefferson St., Chicago, Ill., has opened a branch office at Room 1320, Majestic Bldg., Milwaukee, Wis., under the supervision of H. L. Cole, who was for several years the Milwaukee manager for Manning, Maxwell & Moore, Inc.

Biggs-Watterson Co., 1235 W. 9th St., Cleveland, Ohio, has opened a store and office at 38 S. Jefferson Ave., Dayton, Ohio, where a line of machine tools and supplies is carried for the convenience of customers in the southern part of Ohio. The store is in charge of M. A. Wertman.

Jas. Clark, Jr., Electric Co., Inc., Louisville, Ky., manufacturer of "Willey" electrically driven tools, has removed its Chicago office from 31 N. Jefferson St. to 23-27 S. Jefferson St., here much larger quarters have been obtained. Oscar P. Wodack is district manager.

A. Gulowsen A.S., of Christiania, Norway, manufacturer of the "Grei" heavy oil engine, has incorporated the Gulowsen Grei Engine Co. at Seattle, Wash., and is erecting a large and modern factory where these engines will be manufactured for supplying the American trade.

American Graphite Co., a subsidiary of the Joseph Dixon Crucible Co., Jersey City, N. J., at its last annual meeting of stockholders, elected the following officers: George T. Smith, president; George E. Long, vice-president; J. H. Schermerhorn, treasurer; and Harry Dailey, secretary.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City, announce the removal of their Boston office from 201 Devonshire St. to 84 State St., Room 906. The St. Louis office of the company has been removed from the Chemical Bldg. to the Pierce Bldg., Room 1352.

Aborn Steel Co., Inc., 26 Clarke St., New York City, has opened a branch office at 520 Marine Bank Bldg., Buffalo, N. Y., in order to take care of its increasing business and provide better service. The Buffalo section is in charge of D. J. Mahoney as district manager for the Aborn Steel Co., Inc., and the Century Steel Works.

Joseph Dixon Crucible Co., Jersey City, N. J., at its last annual stockholders' meeting, elected the following officers: George T. Smith, president; George E. Long, vice-president; J. H. Schermerhorn, vice-president; Harry Dailey, secretary; William Koester, treasurer; and Albert Norris, assistant secretary and assistant treasurer.

Electric Tool Repair & Maintenance Co., which makes a specialty of repairing all makes of portable drills, grinders, fans, and small-power motors, and buys and sells second-hand and rebuilt electric tools, has removed from 31 N. Jefferson St., Chicago, Ill., to larger quarters at 23-27 S. Jefferson St. The president of the concern is Oscar P. Wodack.

Malm Engineering Co., Philadelphia, Pa., has leased the exclusive rights to manufacture rotary punching machinery under patents belonging to the Malm Machine Co., Dayton, Ohio. The Malm Engineering Co. is in a position to offer these rotary punching machines for use in the rubber industry as well as in the metal blanking industry for delivery within sixty days after receipt of order.

Driver-Harris Co., Harrison, N. J., has elected the following officers: Frank L. Driver, president; Arlington Bensel, first vice-president; Leon O. Hart, second vice-president; Frank L. Driver, Jr., third vice-president; Percival E. Reeves, treasurer; Stanley M. Tracy, assistant treasurer; and M. C. Harris, secretary. Wilbur B. Driver, formerly vice-president, has retired from active participation in the business.

Young, Corley, & Dolan, Inc., engineers, contractors, and manufacturers' representatives, moved May 1 from their quarters on the eighth floor of the United States Realty Bldg., 115 Broadway, New York City, to much larger quarters on the tenth floor of the same building, where they occupy one-half of the entire floor. This change was made necessary by the rapid growth of their business, especially the machine and small tool divisions.

Brown Instrument Co., Philadelphia, Pa., has opened a new office at 2086 Railway Exchange Bldg., St. Louis, Mo., in charge of Paul H. Berggreen. The demand for Brown pyrometers and other instruments from the southwestern section of the country has been such that the company has felt it necessary to appoint a representative for that district in order to give more prompt attention to its customers in the vicinity of St. Louis.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City, now operate the following works in the United States: Worthington Works, Harrison, N. J.; Blake & Knowles Works, East Cambridge, Mass.; Deane Works, Holyoke, Mass.; Snow-Holly Works, Buffalo, N. Y.; Power & Mining Machinery Works, Cudahy, Wis.; Laidlaw Works, Cincinnati, Ohio; Jeanesville Works, Hazleton, Pa.; International Gas Engine Works, Cudahy, Wis.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has erected a new factory at South Philadelphia, about nine miles from Philadelphia, which is being devoted entirely to the production of ship propulsion machinery for the Navy and the Merchant Fleet. Two steam railroads, an electric line, and the Delaware River, on which the plant is located, afford means of transportation. It is expected that this plant will eventually be of a size comparable with the East Pittsburg works, which now employ approximately 25,000 people and cover a floor space of over 100 acres.

DeMooy Machine Co., 706 Frankfort Ave., N.W., Cleveland, Ohio, manufacturer of high-speed ball bearing drilling machines, was reorganized in April under the name The Demco Machine Tool Co. The capitalization has been increased from $30,000 to $50,000. This firm now has a line of twenty-four styles of high-speed drilling machines, ranging in capacity up to 3/4 inch, and having from one to four spindles and speeds up to 12,000 revolutions per minute. The officers are Herbert O. Evans, president; Charles H. Loew, treasurer; and Arnold Ruetschi, general manager.

Walcott Lathe Co., Jackson, Mich., is erecting another addition to its plant which will add 75,000 square feet to the present floor space. The company is planning to bring out lathes in sizes of 26, 29, 33, and 36 inches, in addition to continuing its regular line. The Walcott Lathe Co. owns and operates the Jackson Machine Tool Co., manufacturer of die-sinking machines, and also the Jackson Shaper Co., manufacturer of Walcott high-duty crank shapers. Several large tracts of land adjoining the present property have been purchased, and further extensions are contemplated.

Syracuse Alloy Steel Co., Inc., Syracuse, N. Y., was formed some time ago, and is now manufacturing a high-speed steel, the object of which is to produce more work between grindings than ordinary high-speed steels. The officers are F. C. Raab, president; M. C. Warwick, first vice-president and general manager; J. E. Lynch, second vice-president; F. Hertrich, secretary; and C. A. Lawton, treasurer. Mr. Raab and Mr. Lynch have both been metallurgists with the Brown-Lipe-Chapin Co., of Syracuse, for some time, and Mr. Lynch has also had long experience in the production of tool steels. The steel manufactured is known as "Arab" steel, and is at present produced from high-speed steel scrap, chips, and certain proportions of new materials. Mr. Warwick, who acts as general manager, was formerly connected with the Brown-Lipe-Chapin Co. in an executive position.

Independent Pneumatic Tool Co., Chicago, Ill., and Aurora Automatic Machinery Co. have been reorganized and will be operated under one corporate name—the Independent Pneumatic Tool Co.—for convenience in handling business. The new company has been incorporated in the state of Delaware with a capitalization of $3,000,000. Both companies were owned by the same interests, the Independent Pneumatic Tool Co. representing the selling division for the "Thor" pneumatic and electric tools, and the Aurora Automatic Machinery Co. being the manufacturing department. The latter company also manufactures and sells "Thor" motorcycles and gasoline engines. The officers of the new company are John D. Hurley, president; Ralph S. Cooper, vice-president; Fletcher W. Buchanan, secretary; and Edward G. Gustafson, treasurer. The general offices of the company are in the Thor Bldg., 1307 S. Michigan Blvd., Chicago.